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NATIONAL DAM INSPECTION PROGRAM. WILLIAMS RUN DAM (NDI ID 432),--ETC(U)
SEP 78 DACW31-78-C-0049
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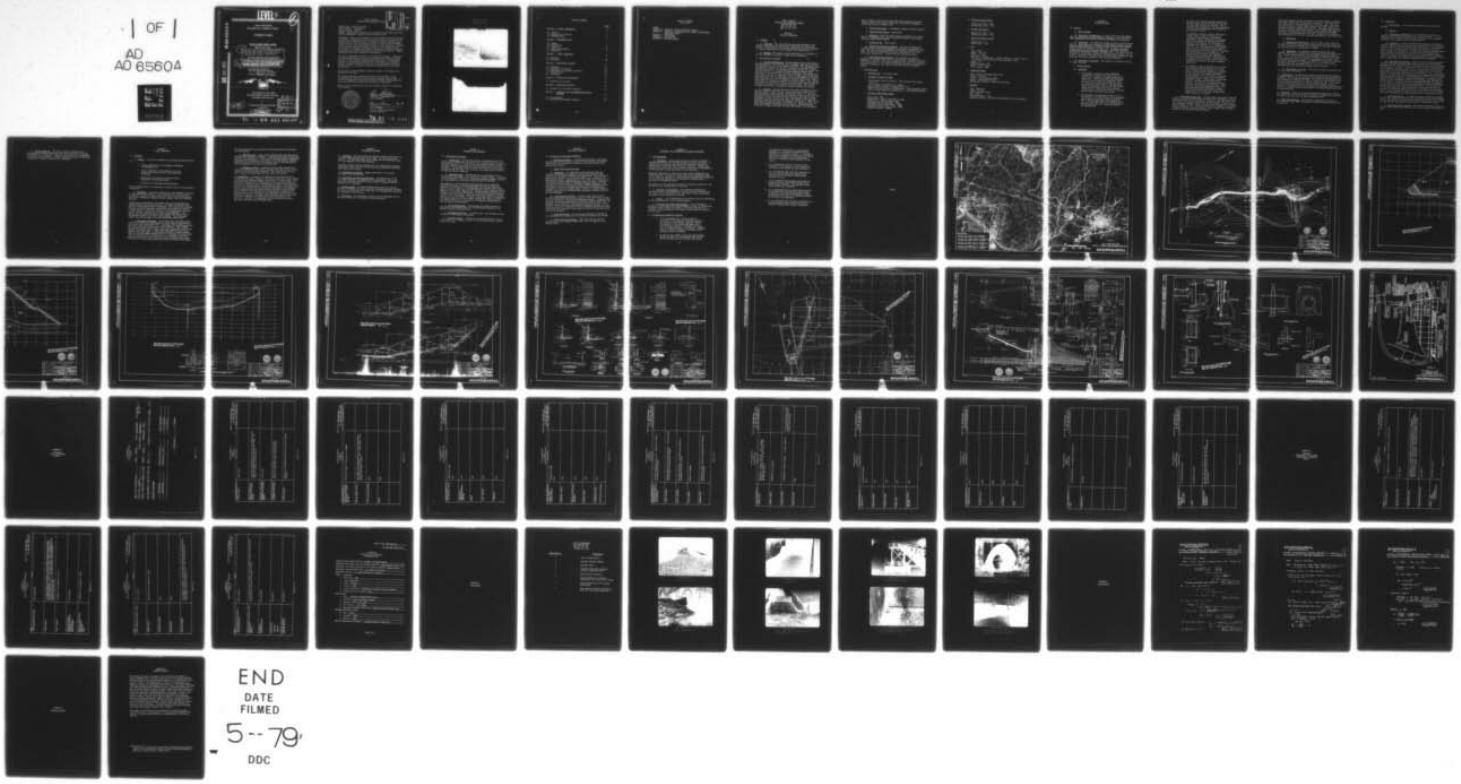

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OHIO RIVER BASIN
WILLIAMS RUN, CAMBRIA COUNTY

PENNSYLVANIA

WILLIAMS RUN DAM
NDI I.D. NO: 432

National Dam Inspection Program, Williams Run Dam (NDI ID 432), Ohio River Basin, Williams Run, Cambria, Pennsylvania.

PHASE I INSPECTION REPORT.

NATIONAL DAM INSPECTION PROGRAM

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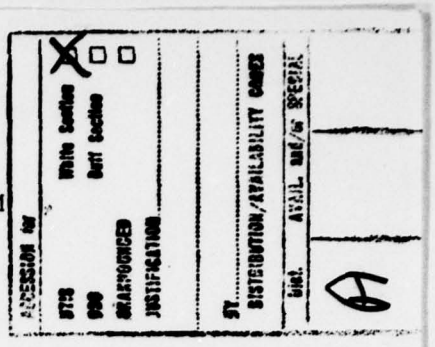
PREPARED FOR

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
BALTIMORE, MARYLAND 21203

BY

D'APPOLONIA CONSULTING ENGINEERS
10 DUFF ROAD
PITTSBURGH, PA. 15235

SEPTEMBER 1978



PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: Williams Run Dam
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Cambria
STREAM: Williams Run, tributary of the South Fork of Black Lick Creek
DATE OF INSPECTION: August 31 and September 8, 1978

ASSESSMENT: Based on the evaluation of the conditions as they existed on the dates of inspection and as revealed by visual observations, the condition of Williams Run Dam is assessed to be good. However, some concern exists as to the structural ability of the spillway discharge channel to pass large flows without damage to the structure. A failure of the spillway discharge channel occurred in 1972 during Tropical Storm Agnes. It appears that repairs essentially followed the original design not necessarily eliminating the causes of the failure. Further investigation of this condition is recommended.

The dam is reportedly situated on old coal mine workings. Although in the present inspection no signs of subsidence were observed, the dam and its vicinity should be periodically inspected by a professional geologist or geotechnical engineer since a potential for subsidence exists. Monuments should be installed on the embankment and on the abutments and be periodically surveyed to document ground movements, if any occur.

The low spot on the embankment should be filled to the design crest elevation of the dam.

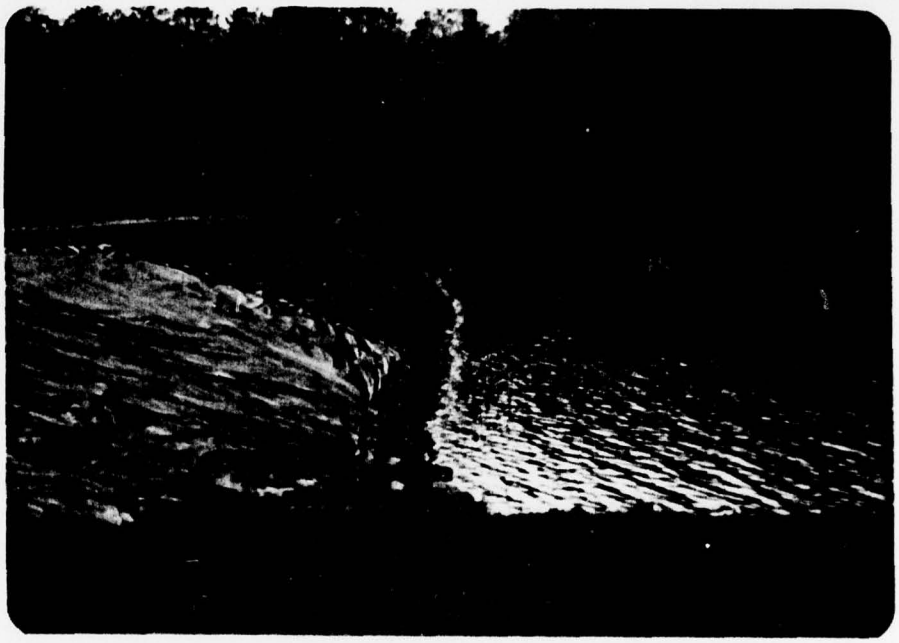
Two swampy areas were observed below the toe of the dam. It is recommended that flow from these areas be monitored and recorded. It is also recommended that the owner develop a formal warning system to alert the downstream residents in the event of emergencies.

Based on the recommended criteria, the spillway capacity is classified to be adequate.

Lawrence D. Andersen, P.E.
Vice President

1 Dec 78

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer



Upstream Face

Downstream Face

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
WILLIAMS RUN DAM
NDI I.D. NO. 432
DER I.D. NO. 11-97

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. The inspection was performed pursuant to the authority granted by The National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project

a. Dam and Appurtenances. The dam consists of an earth embankment approximately 370 feet long with a maximum height of 43 feet from the downstream toe and a crest width of 20 feet. The combined primary and emergency spillway for the dam is located on the right abutment (looking downstream). The spillway structures consist of an ogee overflow section and a rectangular concrete discharge channel which terminates at an apron at the toe level of the dam. The 50-foot-wide ogee control section is located at a level 13 feet below the dam crest. The outlet works for the dam consist of a 60-inch-diameter corrugated metal drainpipe and a 12-inch-diameter cast-iron supply line. Both of these pipes are encased in concrete with cutoff collars. Flow through these pipes is controlled by manually operated sluice gates located at an intake structure at the upstream end of the pipes. The 60-inch drainpipe constitutes the emergency drawdown facility for the dam.

b. Location. Williams Run Dam is located on Williams Run about 1000 feet north of Route 422 and 4 miles northeast of Nanty Glo in Cambria Township, Cambria County, Pennsylvania (Plate 1). Below the dam Williams Run flows south and goes through an arch culvert under the embankment of Route 422 (Plate 2) and joins the South Fork of Black Lick Creek one mile south of Route 422. The height of the Route 422 embankment from the streambed is estimated to be 60 feet. There is one house located along the course of Williams Run. Nanty Glo, which is the first community downstream from the dam, is located along the South Fork of Black Lick Creek six miles downstream. It is estimated

that a failure of Williams Run Dam would cause significant property damage in Nanty Glo, but not a high loss of life due to temporary impounding behind the highway fill.

c. Size Classification. Intermediate (based on 43-foot height).

d. Hazard Classification. Significant.

e. Ownership. Nanty Glo Water Authority (address: Mr. Jannie Mulato, Borough Secretary, Nanty Glo Water Authority, First Street, Nanty Glo, Pennsylvania 15943).

f. Purpose of Dam. Water supply.

g. Design and Construction History. The dam was designed by L. Robert Kimball Consulting Engineers of Ebensburg, Pennsylvania and Glace and Glace Consulting Engineers of Harrisburg, Pennsylvania in 1954. The dam was constructed by Sanctis Construction, Inc., of Pittsburgh, Pennsylvania. Construction was completed in 1956.

h. Normal Operating Procedure. The reservoir is normally maintained at spillway crest level (Elevation 2020) leaving 13 feet of freeboard to the top of the dam at Elevation 2033. All inflow occurring when the reservoir is at or above the spillway elevation is discharged through the spillway. The blow-off valve for the dam is normally closed.

1.3 Pertinent Data

a. Drainage Area - 4.8 square miles

b. Discharge at Dam Site (cfs)

Maximum known flood at dam site - 1500 (Tropical Storm Agnes in 1972)
Outlet conduit at maximum pool - Unknown
Gated spillway capacity at maximum pool - N/A
Ungated spillway capacity at maximum pool - 7200 (Elevation 2033)
Total spillway capacity at maximum pool - 7200 (Elevation 2033)

c. Elevation (USGS Datum) (feet)

Top of dam - 2033
Maximum pool - 2031.3 (low spot on crest)
Normal pool - 2020 (spillway crest)
Upstream invert outlet works - 1992
Downstream invert outlet works - 1986±
Streambed at center line of dam - 1986±
Maximum tailwater - Unknown

d. Reservoir Length (feet)

Normal pool level - 6000
Maximum pool level - 6500

e. Storage (acre-feet)

Normal pool level - 480
Maximum pool level - 1530

f. Reservoir Surface (acres)

Normal pool - 70
Maximum pool - 120+

g. Dam

Type - Earth
Length - 370 feet
Height - 43 feet
Top width - 20 feet
Side slopes - Downstream: 2.5H:1V; Upstream: 2.5H:1V (crest to Elevation 2010) and 3.0H:1V (below Elevation 2010)
Zoning - Yes
Impervious core - Yes
Cutoff - Cutoff trench
Grout curtain - None

h. Regulating Outlet

Type - 60-inch corrugated metal pipe
Length - 220 feet
Closure - Sluice gate at intake
Access - From downstream end
Regulating facilities - Upstream sluice gate

i. Spillway

Type - Ogee weir
Length - 50 feet
Crest elevation - 2020
Gate - None
Upstream channel - Lake
Downstream channel - 50-foot-wide rectangular concrete channel

SECTION 2
ENGINEERING DATA

2.1 Design

a. Data Available

(1) Hydrology and Hydraulics. A state report entitled, Report Upon the Application of Nanty Glo Water Authority, dated November 4, 1954, summarizes the available hydrology and hydraulic information.

(2) Embankment. The embankment design was based on two engineer reports: Final Report on a Design of a Water Supply Project for the Nanty Glo Water Authority, prepared by Glace and Glace and L. Robert Kimball Consulting Engineers, November 1954; and Report on Soils Investigations for the Nanty Glo Reservoir, prepared by Manu-Mine Research and Development Company, September 1954. The reports include discussions on hydrology, hydraulics, and geotechnical aspects of the project. Available information also included design drawings and technical specifications prepared by the consulting engineers.

(3) Appurtenant Structures. The available information consists of design drawings.

b. Design Features

(1) Embankment

a. As designed, the dam is a zoned embankment consisting of a select fill impervious core section with random fill sections upstream and downstream. A three-foot-thick sand and gravel filter is located under the downstream slope. The impervious core section extends to top of rock through a cutoff trench. The sand drain under the downstream slope starts 30 feet downstream from the center line of the dam and terminates at a rock fill at the toe of the dam. Plate 3 shows the typical dam section.

b. The embankment was designed to have a 2.5 to 1 (horizontal to vertical) slope on the downstream face broken by a five-foot berm at Elevation 2017. The upstream slopes were designed to be 2.5 to 1 from crest level to a 12-foot bench at Elevation 2010 and 3 to 1 below the bench to the upstream toe.

c. A review of the regional geology (Appendix E) indicates that the Lower Kittanning coal seam has been mined beneath the dam site. This condition was recognized by the design engineers and the following assessment was included in the engineer's report:

"Independent geological surveys conducted at various times, as well as results of an investigation specifically performed to establish a basis of design for the proposed dam, without exception, indicated that the problem of settling due to the presence of abandoned coal workings, at an elevation at least 235 feet below the base of the proposed dam is not to be considered serious and no special measures must be provided in the design of the dam because of this condition. The various strata of shales and sandstones underlying the reservoir area, generally lie in nearly horizontal planes. There has been no faulting in the area which would affect the stability of the dam or its water retaining capacities."

d. The engineer's report indicates that at least three core borings were drilled at the dam site at depths varying between 35 to 70 feet. Plate 4 illustrates the subsurface condition at the dam site. The typical subsurface profile consists of 10 to 15 feet of residual soils underlain by a thin layer of sandstone followed by shale. Fifteen auger borings were drilled to investigate potential borrow sources. The soil tests on potential borrow materials consisted of classification, compaction, and unconfined compression tests. The borrow materials were classified to range from clays to sandy loams with liquid limits ranging from 25 to 38 percent and plasticity indices from 8 to 15 percent.

c. Appurtenant Structures. The appurtenant structures of the dam consist of an ogee-crested overflow section and a rectangular spillway discharge channel which terminates at an apron at the toe level of the dam. Plate 5 illustrates the profile of the spillway. The walls of the rectangular concrete channel are cantilever type and have a maximum height of about 27 feet. The slab section of the channel is underlain by sand and gravel to permit drainage. Plate 6 shows the structural details of the spillway discharge channel.

The outlet pipe for the dam consists of a 60-inch-diameter corrugated metal pipe located left of the spillway (Plate 7). A 12-inch cast-iron supply line is located parallel to the outlet pipe. The outlet pipe was encased in six-inch-thick concrete and cutoff collars were provided to control seepage along the pipe. The supply line was also encased in concrete with cutoff collars. Flow through these pipes is controlled by manually operated sluice gates located at an intake structure at the upstream toe of the dam. Plates 8 and 9 illustrate the configuration of the inlet structure and details of the outlet pipe.

d. Design Data

(1) Hydrology and Hydraulics. The 1954 state report indicates that the 50-foot-wide ogee-crested spillway would pass the design flow of 4080 cubic feet per second (cfs), equivalent to a runoff of 850 cfs per square mile with a freeboard of 4.9 feet.

(2) Embankment. The engineer's report indicates that some stability analysis was conducted for the design of the dam based on the shear strength values obtained from unconfined compression strength tests. It is reported that the shear strength of the soils were taken as 790 pounds per square foot (psf) corresponding to one-half of the unconfined compressive strength. No quantitative results were reported. The report indicates that utilization of a 2.5 to 1 slope on the downstream side and the combination of 2.5 to 1 and 3 to 1 for the upstream side would provide an adequate factor of safety.

(3) Appurtenant Structures. There are no design calculations for the appurtenant structures.

2.2 Construction. No construction progress information was available. It appears that the dam was constructed according to the specifications prepared by the consulting engineers. The specifications required that the foundation be stripped to a depth of about five feet and the cutoff trench be carried down two feet into the foundation rock. The specifications required 100 percent of standard Proctor density for the earthwork. The engineer's report required that adequate field inspection should be provided to insure construction of the dam in accordance with the specifications.

2.3 Operation. There are no formal operating procedures for the dam. The spillway of the dam is uncontrolled and has no operational features. The outlet pipe valve for the dam is normally closed.

2.4 Other Investigations. The available information indicated no investigations other than the reports of periodic inspections conducted by the state.

2.5 Evaluation

a. Availability. The available information was provided by PennDER.

b. Adequacy

(1) Hydrology and Hydraulics. The available information is limited to providing the design capacity of the spillway. It is not considered to be adequate to assess the conformity of the spillway capacity to the current spillway design criteria.

(2) Embankment. Review of geotechnical aspects of the design indicates that the design incorporated a limited subsurface investigation and limited soils testing and stability analyses. The design procedure is not considered to be in conformance with the currently accepted practice for analysis. However, the design incorporated such basic elements as impervious core, cutoff trench backfilled with impervious material extending to top of rock, and internal drainage system. In general, no significant deficiencies were found that would raise concern about the overall performance of the embankment.

(3) Appurtenant Structures. Nanty Glo Water Authority personnel reported that during Tropical Storm Agnes a portion of the spillway discharge channel slab had failed. The extent of the repairs performed was observed in the field. The review of the structural configuration of the spillway discharge channel in view of this past failure raised some concern as to the stability of the retaining walls if a similar failure of the spillway were to occur in the future. This concern was based on the fact that the retaining walls are supported on the concrete slab forming the bottom of the spillway channel, and a failure in this slab may result in failure of the retaining walls. Although various causes, such as hydrostatic uplift or suction pressures, may have led to the failure, it appears from visual observations that the failure of the spillway bottom resulted from high suction pressures generated by high flow velocities over the spillway bottom. To the extent it can be determined, the repair measures did not incorporate any provisions for controlling suction pressures. Therefore, it is possible that a similar failure may happen in the future in the event of large flows over the spillway, thereby endangering the integrity of the dam.

c. Operating Records. No formal operating records are available for the dam. Nanty Glo Water Authority personnel reported that maximum flow at the dam site occurred during Tropical Storm Agnes and the depth of flow over the spillway was on the order of three to four feet.

d. Post-Construction Changes. The spillway discharge channel was repaired after the failure that occurred during Tropical Storm Agnes in 1972.

e. Seismic Stability. The dam is located in Seismic Zone 1 and based on the visual observations the static stability of the dam is considered to be adequate. Therefore, according to the recommended criteria for the evaluation of seismic stability of dams, the structure is presumed to present no hazard from earthquakes.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The on-site inspection of Williams Run Dam consisted of:

1. Visual inspection of the embankment, abutments, and embankment toe.

2. Visual examination of the spillway, its components and outlet pipe and other appurtenant structures.

3. Observation of factors affecting the runoff potential of the drainage basin.

4. Evaluation of downstream hazard potential.

Specific observations are illustrated in Plate 10 and in the photographs in Appendix C.

b. Embankment. The general inspection of the embankment consisted of searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils, and observing general maintenance conditions, vegetative cover, erosion, and other surficial features.

A depression was observed on the upstream face of the dam below the bridge leading to the intake structure. No signs of distress associated with this depressed area was observed. The riprap on the upstream face was partially decomposed, resulting in minor shoreline erosion. A narrow section of the crest adjacent to the spillway wall was found to have settled, resulting in a low spot on the embankment. Two swampy areas were observed about 60 feet downstream from the toe of the dam which appear to be due to under seepage. Flow from these swampy areas was estimated to be five gallons per minute (gpm).

c. Appurtenant Structures. The spillway structures and spillway crest were examined for deterioration or other signs of distress and obstructions that would limit flow. In general, the spillway structures and outlet works were found to be in good condition. Minor seepage was observed between the interface of the ogee section and walls of the spillway discharge channel. These flows were estimated to be in the range of two to four gpm. As previously discussed, a concern exists that the spillway channel bottom may fail in the event of a major flood since the repairs did not include measures to eliminate the suction pressures generated by large flows which were presumed to have caused the failure of the spillway during the passing of Tropical Storm Agnes.

The outlet pipe valve was operated by borough personnel and observed to be functional.

d. Reservoir Area. A map review indicates that the watershed is predominantly covered by woodlands. Scattered homes exist on the upper reaches of the watershed. A review of the regional geology (Appendix E) indicates that shorelines are not likely to be susceptible to massive landslides which would affect the storage volume of the reservoir or cause overtopping of the dam by displaced water.

e. Downstream Channel. Downstream from the dam, Williams Run flows about 1000 feet south where it passes under Route 422 in an arch culvert in the 65-foot-high embankment. The stream joins the South Fork of Black Lick Creek about one mile south of Route 422.

3.2 Evaluation. In general, the condition of Williams Run Dam is considered to be good. However, some concern exists as to the integrity of the spillway discharge channel in the event of a major flood. The depression observed on the upstream face of the dam was attributed to the as-built configuration of the dam since no signs of distress were observed to indicate movement of the upstream slope at the present time. Riprap on the upstream face of the dam is considered to be inadequate. It is recommended that the owner evaluate the need for placing additional riprap on the upstream face to avoid further erosion of the shoreline and fill the low spot on the embankment to the design crest elevation of the dam. The swampy areas observed below the toe of the dam are not considered to affect the overall performance of the structure. However, it is suggested that the owner should monitor and record the flows from the seepage area.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedure. The water authority personnel reported that there are no formal operating procedures for the dam. The only operational feature of the dam which might affect safety is the outlet pipe valve if it is required to lower the reservoir.

Clearing of debris from the spillway as it is required and continued inspection of the facilities are the principal maintenance operations which would affect safety.

4.2 Maintenance of the Dam. General maintenance of the dam is considered to be satisfactory.

4.3 Maintenance of Operating Facilities. The maintenance of the operating facilities is considered to be satisfactory. The outlet pipe sluice gate was operated by water authority personnel and was observed to be functional.

4.4 Warning System. No formal warning system exists for the dam. The dam is maintained by water authority personnel operating from Nanty Glo about six miles south of the dam site. No communication facilities are available at the dam site.

4.5 Evaluation. The maintenance condition of the embankment and the operating facilities is considered to be satisfactory.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Williams Run Dam has a watershed area of 4.8 square miles and impounds a reservoir with a surface area of 70 acres at normal pool level. A 50-foot-wide ogee-crested spillway located on the right abutment constitutes the flood discharge facility for the reservoir. The spillway crest is located at a level 11.3 feet below a low spot on the dam crest. As it exists, the spillway has a capacity of 7200 cfs with no freeboard.

b. Experience Data. Williams Run Dam is classified to be an "intermediate" size dam in the "significant" hazard category. According to the recommended criteria for evaluating emergency spillway capacity, such impoundments are required to pass one-half to full PMF.

The adequacy of the spillway was analyzed based on the simplified procedure developed by the Baltimore District, Corps of Engineers. Based on this procedure, it was determined that the PMF inflow hydrograph will have a peak flow of 14,000 cfs and a total volume of approximately 6700 acre-feet (Appendix D). Further analysis according to the procedure indicated that the spillway is capable of passing 67 percent of PMF without overtopping. Since the size classification of the dam based on its 43-foot height is closer to the lower limit of intermediate size dams (larger than 40-foot height, smaller than 100-foot height), the spillway capacity is considered to be adequate corresponding to size and hazard classification.

c. Visual Observations. As discussed in previous sections of this report, some concern exists on the structural integrity of the spillway channel during high flows.

d. Overtopping Potential. As stated above, the spillway can pass 67 percent of PMF without overtopping.

e. Spillway Adequacy. Sixty-seven percent PMF spillway capacity is considered to be adequate relative to the size and hazard classification of the dam.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. As discussed in Section 3, the field observations did not reveal any signs of distress that would significantly affect the stability of the dam at this time and none were reported in the past.

b. Design and Construction Data

(1) Embankment. The engineer's report indicated that the stability of the dam was analyzed based on shear strength values obtained from unconfined compressive strength tests. No quantitative results were reported. It is reported that 2.5 to 1 slopes on the downstream face and a combination of 2.5 to 1 and 3 to 1 slopes on the upstream face would provide an adequate factor of safety. Although the testing procedure used for obtaining strength parameters is not considered to be in conformance with the currently accepted practice for stability analysis, the adopted slopes for the embankment are considered to be in a reasonable range. Further, no visual signs of distress were observed to indicate any significant stability problems for the embankment.

(2) Appurtenant Structures. In view of the failure of the spillway slab during Tropical Storm Agnes in 1972, some concern exists as to the stability of the spillway discharge channel. It appears that spillway repairs have essentially followed the original design with the exception of installation of several relief wells at the toe of the spillway chute to drain the sand blanket underneath the slab. No provisions were made to eliminate the suction pressures generated by large flows which are suspected to have caused the failure of the dam during Tropical Storm Agnes.

c. Operating Records. The structural stability of the dam is not considered to be affected by the operational features of the dam.

d. Post-Construction Changes. There have been no reported modifications to the original design other than the repairs of the spillway chute.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment

a. Assessment. Visual observations and review of available information indicate that Williams Run Dam is in good condition. It appears that the dam was constructed with reasonable care and no unsatisfactory conditions were reported in the past. Swampy areas below the toe of the dam in their present extent are not considered to be affecting the overall performance of the structure.

Reportedly (Appendix E), there are old coal mine workings 235 feet beneath the dam. Although no visual signs of mine subsidence exist at this time, the dam and its vicinity should be periodically inspected by a professional geologist or a geotechnical engineer since a potential for subsidence exists.

The capacity of the spillway was found to be adequate relative to the hazard and size classification for the dam.

b. Adequacy of Information. The available information in conjunction with visual observations and the previous experience of the inspectors are considered to be sufficient to make a reasonable assessment of the conditions of the dam.

c. Urgency. The recommendations listed below should be implemented as soon as practicable or on a continuing basis.

d. Necessity for Further Investigation. It is considered necessary to investigate the causes leading to failure of the spillway discharge channel during the passage of Tropical Storm Agnes and determine necessary measures to be taken to avoid similar occurrence in the future.

7.2 Recommendations/Remedial Measures

1. It is recommended that further studies be undertaken to determine the underlying causes of the failure of the spillway discharge channel, the adequacy of the repairs performed, and to take necessary measures to eliminate the potential of a similar failure in the future. Measures, such as aerating the nappe to eliminate suction pressures, may be considered.

2. In view of the presence of old coal mine workings beneath the dam, it is recommended that the dam and its vicinity and the reservoir area should

be inspected periodically by a professional geologist or a geotechnical engineer since a potential for subsidence exists. It is recommended that monuments be installed on the embankment and the abutments and be periodically surveyed to document ground movements, if any occur.

3. It is recommended that the low spot on the embankment crest adjacent to the spillway wall be filled to the design dam crest elevation.

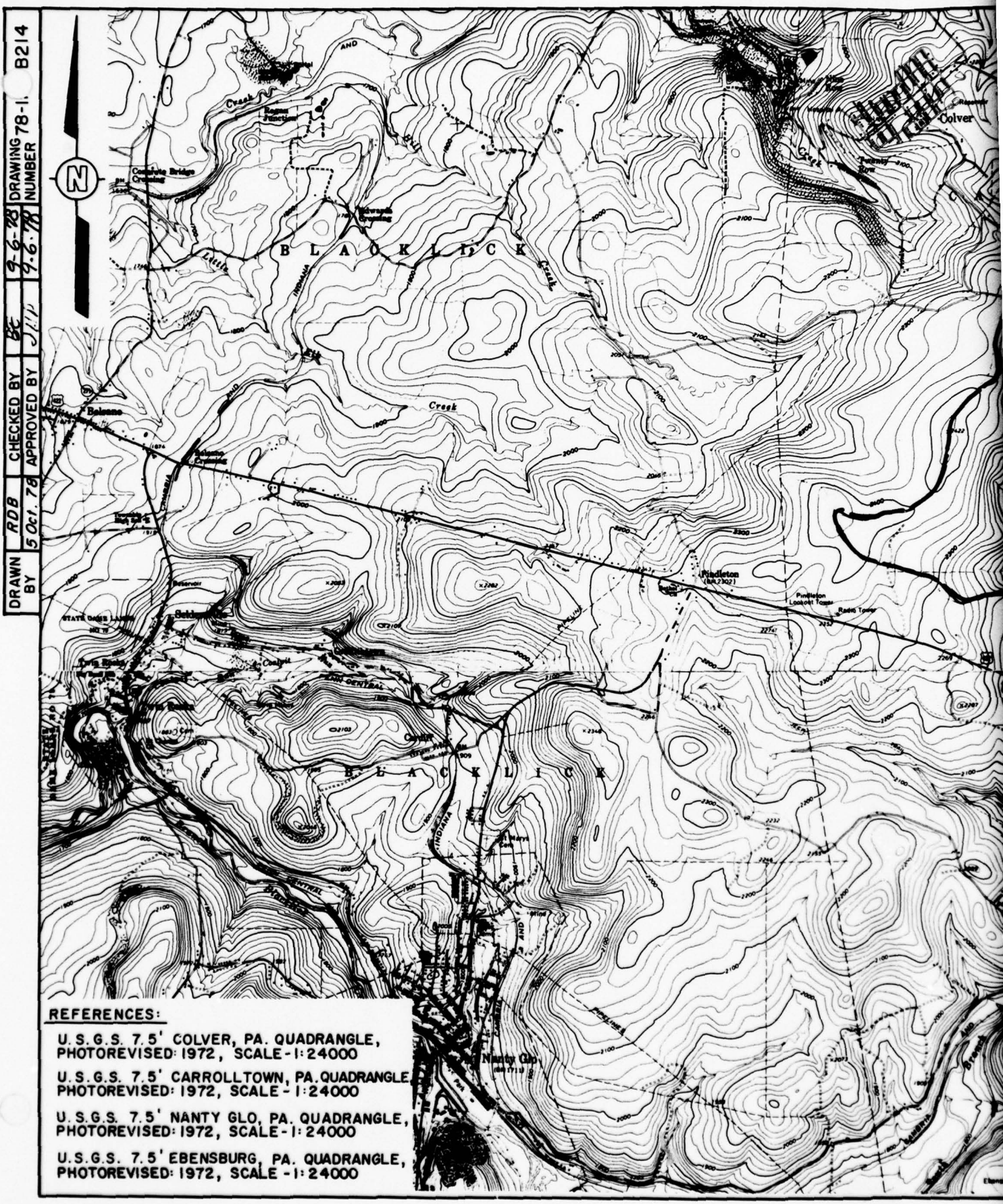
4. It is recommended that the owner evaluate the need for placing additional riprap on the upstream face of the dam to avoid further shoreline erosion.

5. It is recommended that seepage flows from the swampy areas be collected and the quantities monitored and recorded. The turbidity of the flows should also be observed.

6. It is recommended that the owner should provide around-the-clock surveillance during periods of unusually heavy runoff and develop a formal warning system to alert the downstream residents in the event of an emergency.

7. It is recommended that the owner be advised that the dam and appurtenant structures should be inspected regularly and properly maintained.

PLATES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Nanty Glo
REFERENCES:
U.S.G.S. 7.5' COLVER, PA. QUADRANGLE, PHOTOREVISED: 1972, SCALE - 1: 24000
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U.S.G.S. 7.5' NANTY GLO, PA. QUADRANGLE, PHOTOREVISED: 1972, SCALE - 1: 24000
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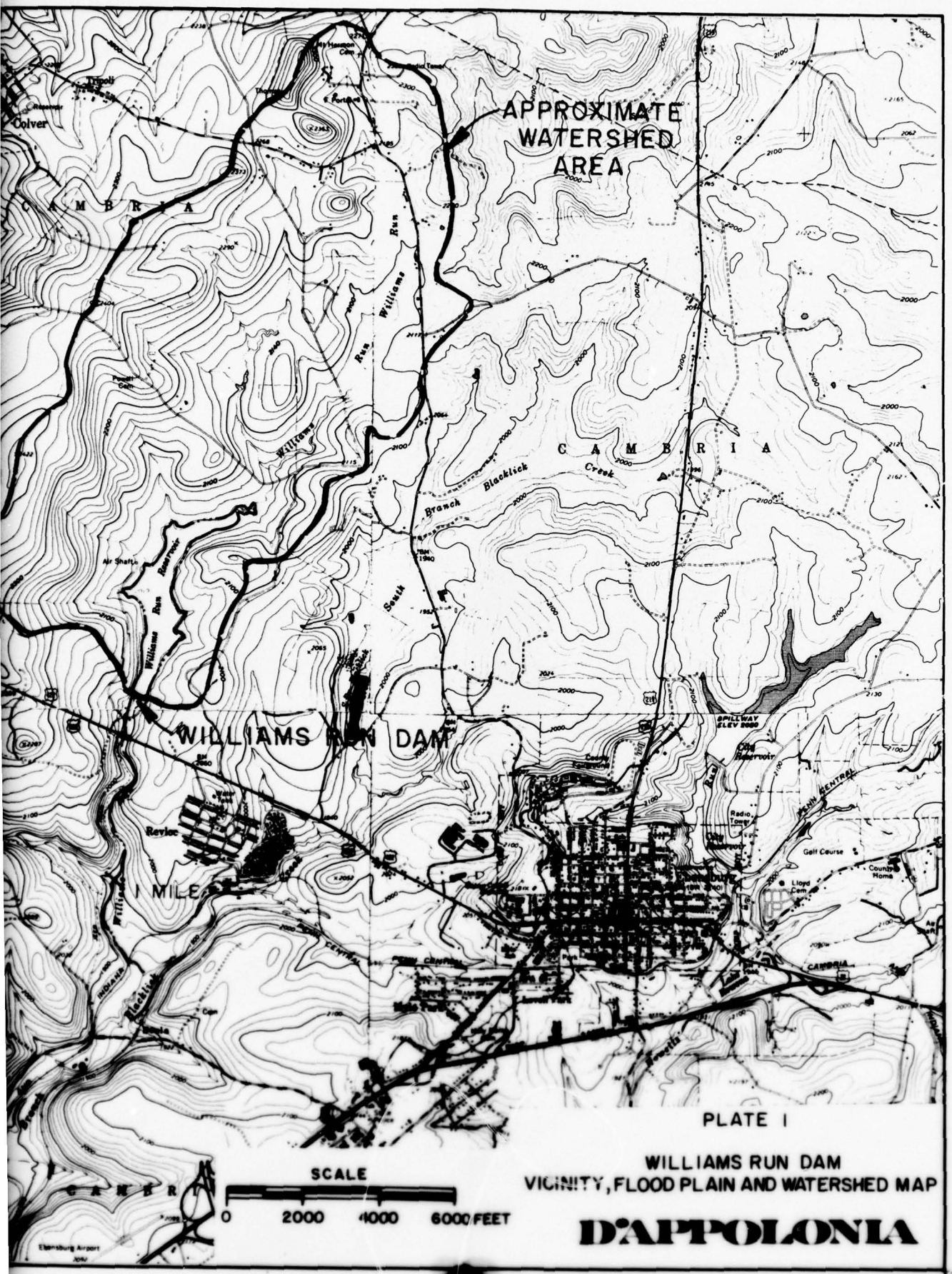

PLATE 1

WILLIAMS RUN DAM
VICINITY, FLOOD PLAIN AND WATERSHED MAP

D'APPOLONIA

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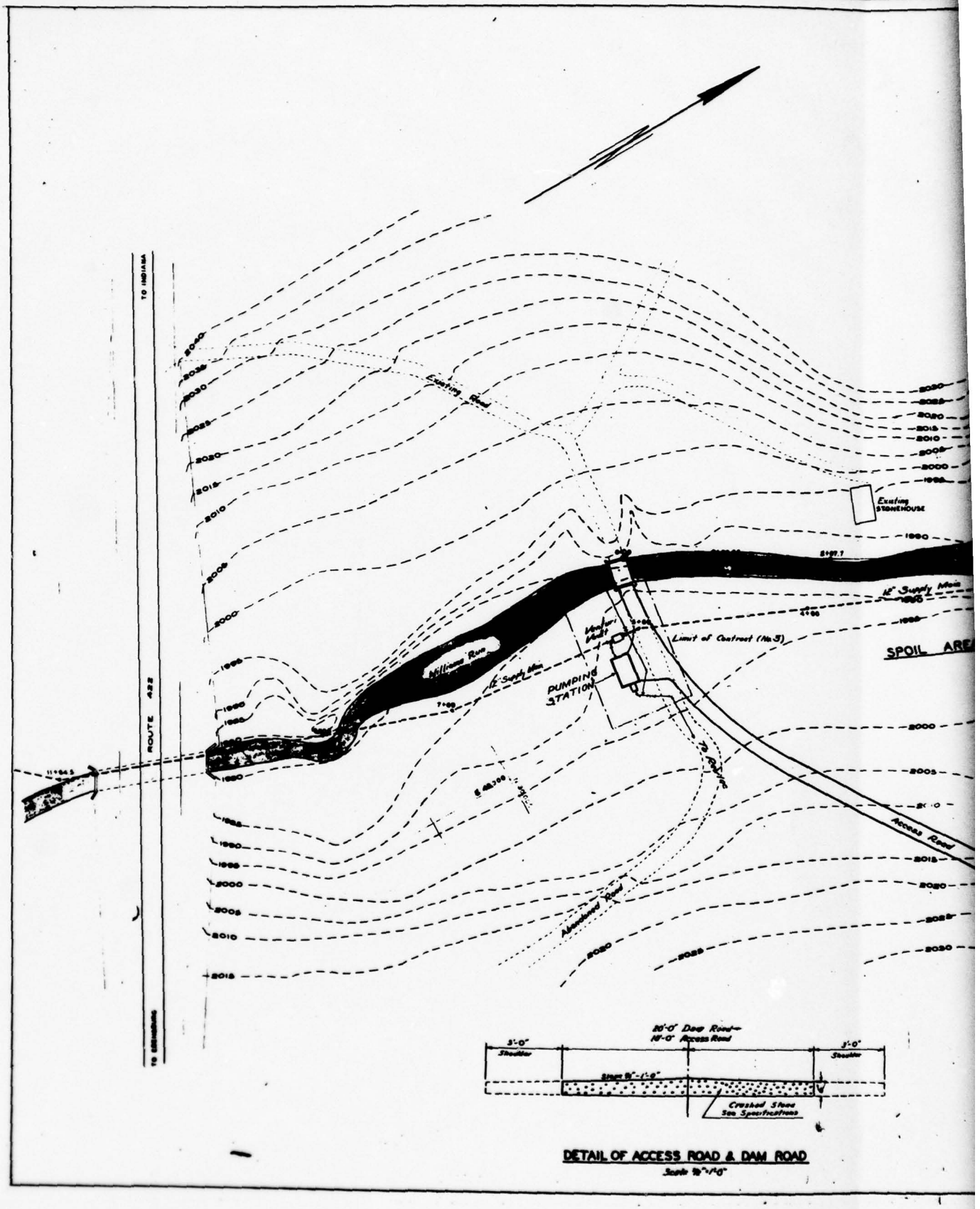
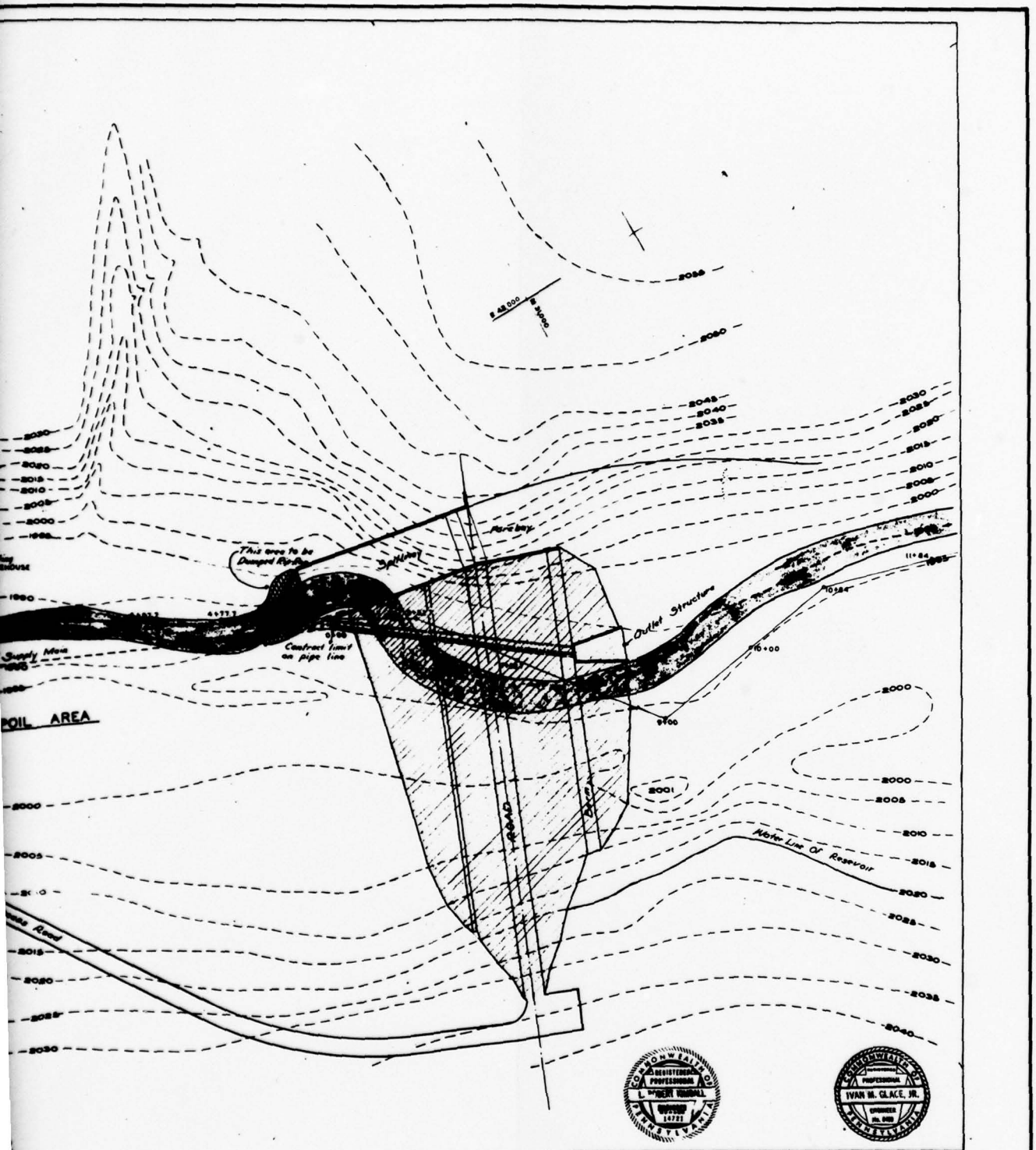


DETAIL OF ACCESS ROAD & DAM ROAD

Scale 1/8"=1'-0"



COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL L. ROBERT KIMBALL 14721

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL IVAN M. GLACE, JR. ENGINEER No. 9155

NANTY GLO WATER AUTHORITY

CONTRACT 1

GENERAL SITE PLAN

GLACE & GLACE, L. ROBERT KIMBALL

CONSULTING ENGINEERS

HARRISBURG, PENNA. EBENSBURG, PENNA.

DRAWN	DATE	SCALE, 1"=50'	SHEET 3 OF 9
CHECKED W.C. Hubert	DATE	FILE CODE 5407	
APPR. BY I.M. Glace Jr.	DATE		

PLATE 2

D'APPOLONIA

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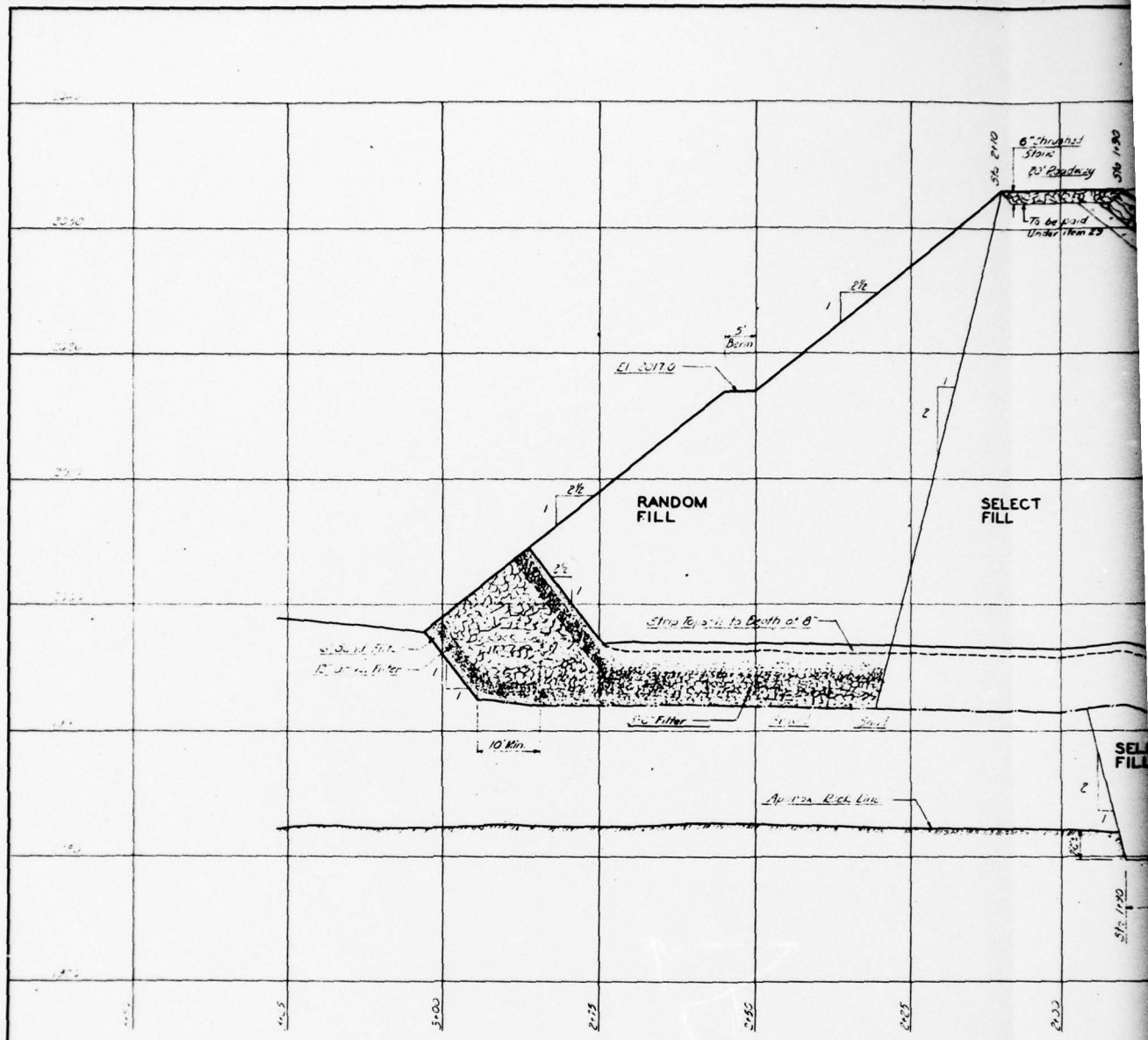
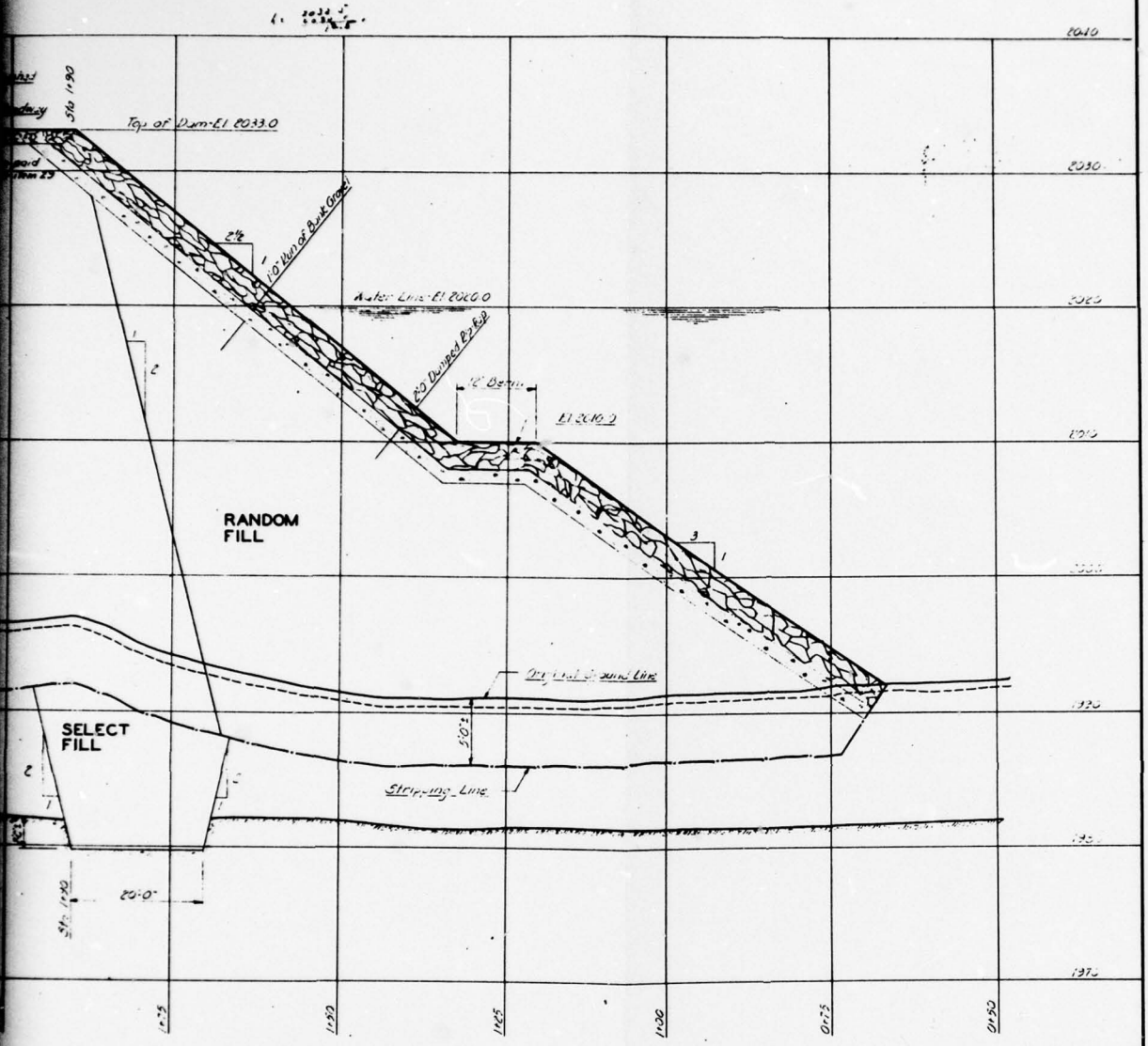
	9-5-78	APPROVED BY	[illegible]	9-6-78		





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IVAN M. GLACE, JR. — PROFESSIONAL ENGINEER — No. 0480 — COMMONWEALTH OF PENNSYLVANIA

L. ROBERT KIMBALL — REGISTERED PROFESSIONAL — No. 14721 — COMMONWEALTH OF PENNSYLVANIA

MARK	REVISIONS	DATE

NANTY GLO WATER AUTHORITY

CONTRACT 1

CROSS SECTION AT STATION 2+50

GLACE & GLACE, L. ROBERT KIMBALL
CONSULTING ENGINEERS
HARRISBURG, PENNA. EBENSBURG, PENNA.

DRAWN BY RED 10-12-54 DATE
CHKD. BY J.C.H. DATE
APPD. BY I.M.G. DATE

SCALE HOR. 1"=5' VER. 1"=5'
SHEET NO. 6
FILE CODE 5407
OF 11

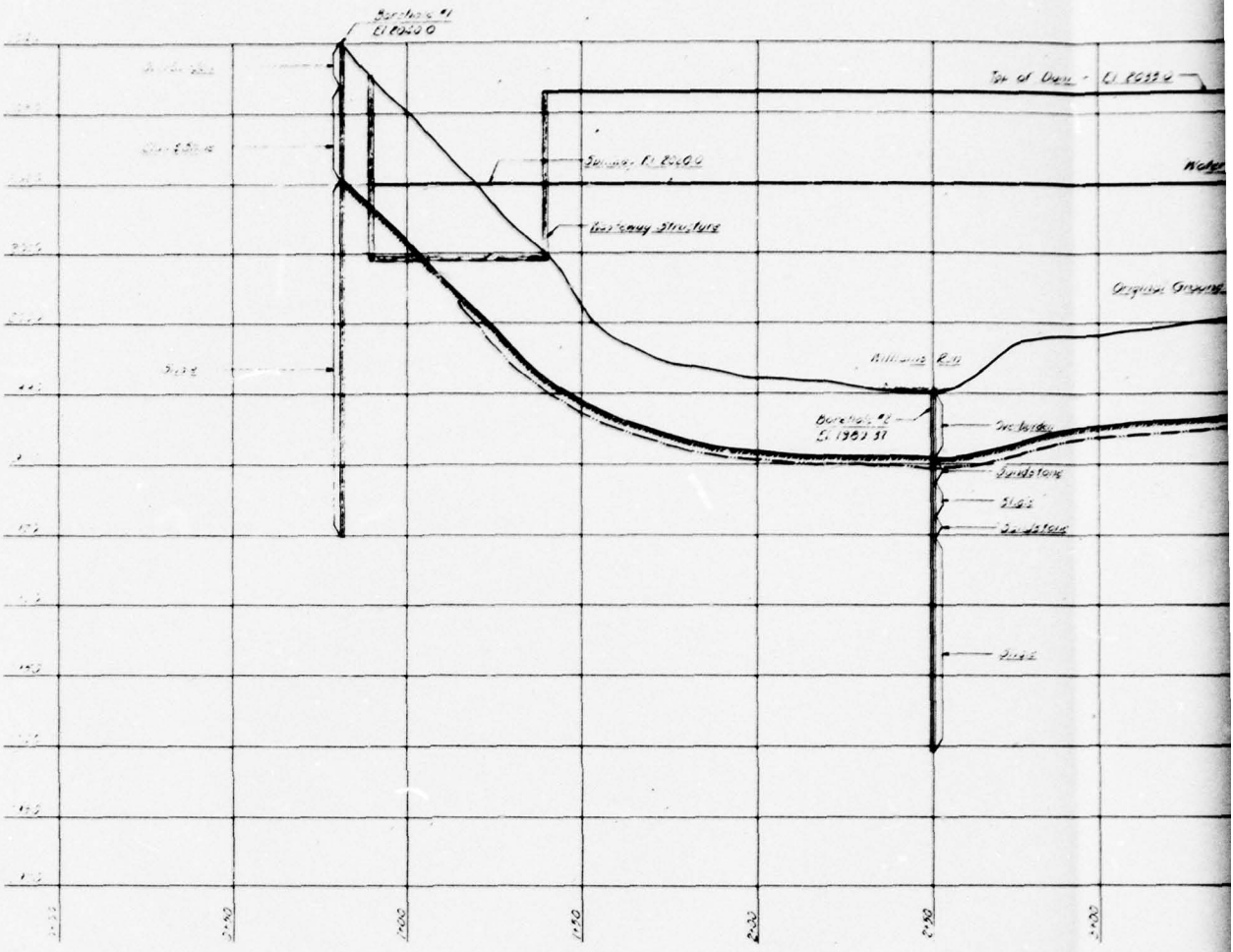
PLATE 3

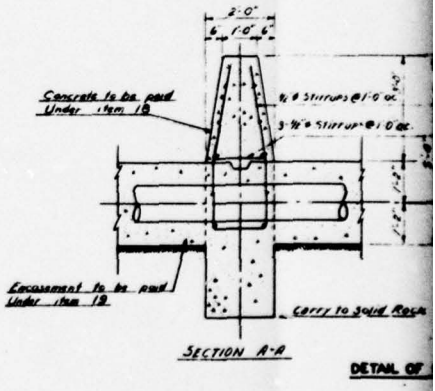
D'APPOLONIA

1

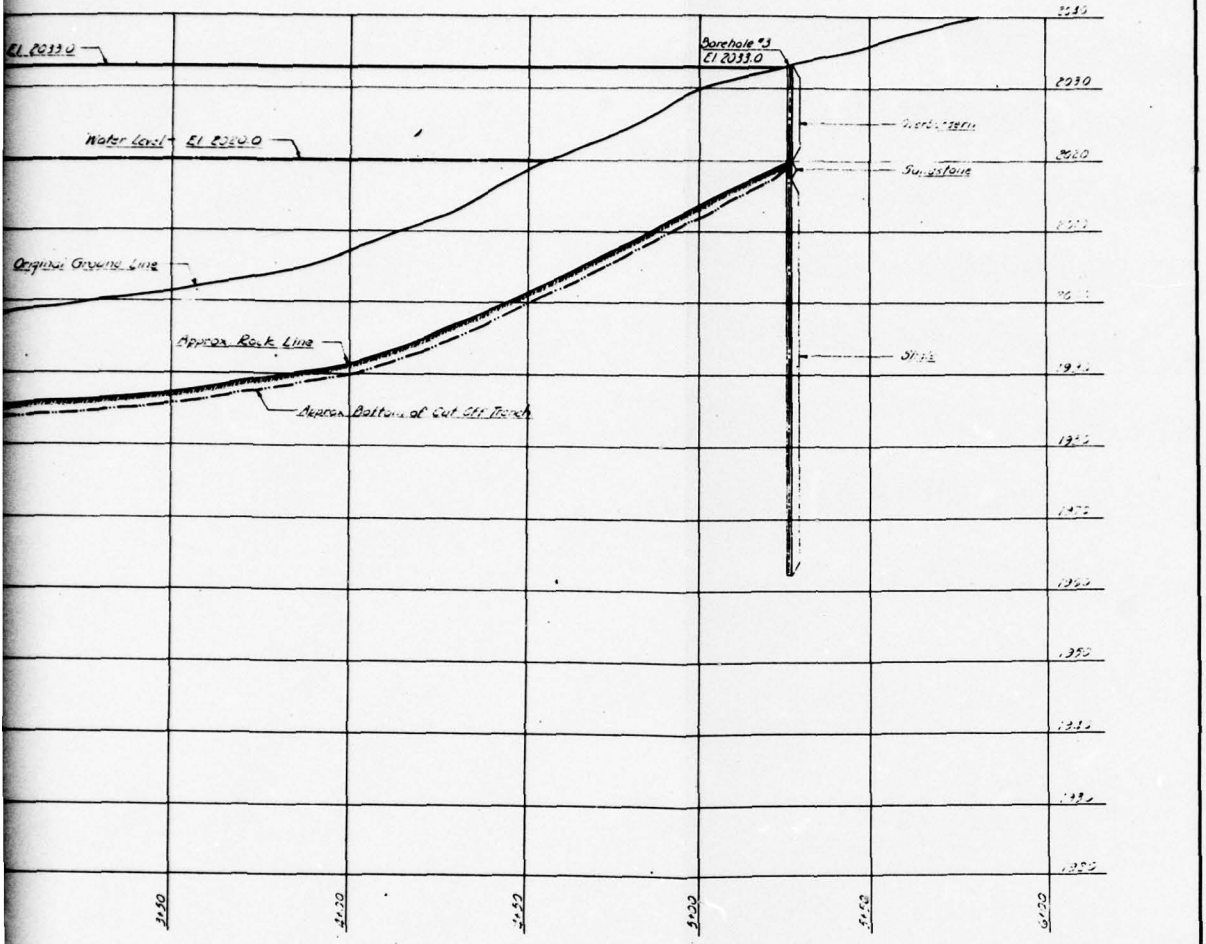
2

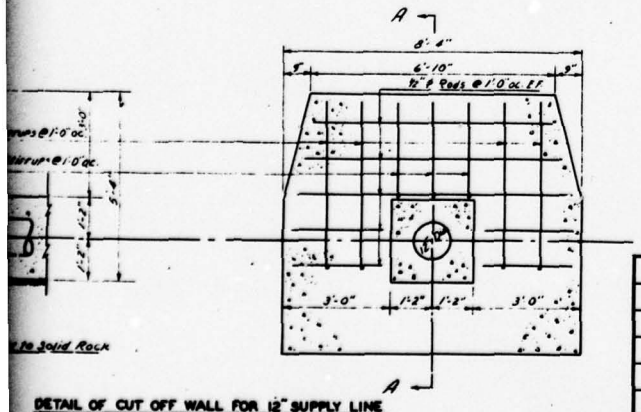
DRAWN BY	trs	CHECKED BY		9-6-78	DRAWING NO. 14-B180
	9-5-78	APPROVED BY	JHD	9-6-78	





DETAIL OF





DETAIL OF CUT OFF WALL FOR 12" SUPPLY LINE
SCALE 1/2"=1'-0"

IVAN M. GLACE, JR. — PROFESSIONAL ENGINEER — No. 9169 — PENNSYLVANIA

COMMONWEALTH OF PENNSYLVANIA — REGISTERED PROFESSIONAL — L. ROBERT KIMBALL — 14721

MARK	REVISIONS	DATE

NANTY GLO WATER AUTHORITY
CONTRACT I
LONGITUDINAL SECTION THROUGH CENTERLINE OF DAM
GLACE & GLACE, L. ROBERT KIMBALL
CONSULTING ENGINEERS
HARRISBURG, PENNA. EBENSBURG, PENNA.

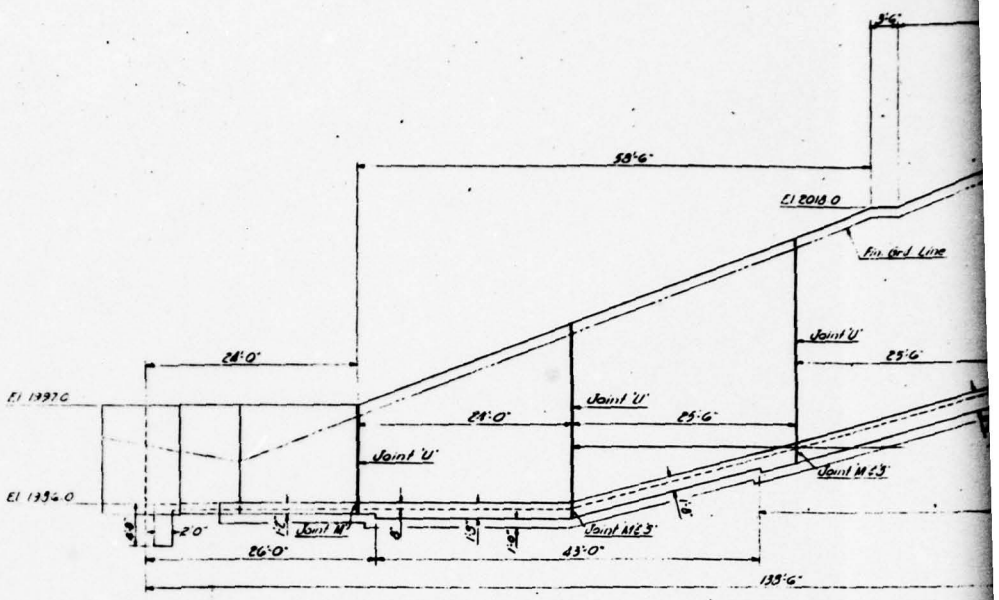
DESIGN BY RED 10-12-84 DATE
CHKD. BY DATE
APPD. BY DATE

SCALE HOR 1"=20' VER 1"=10'
FILE COPY 5467
SHEET NO. 5 OF 11

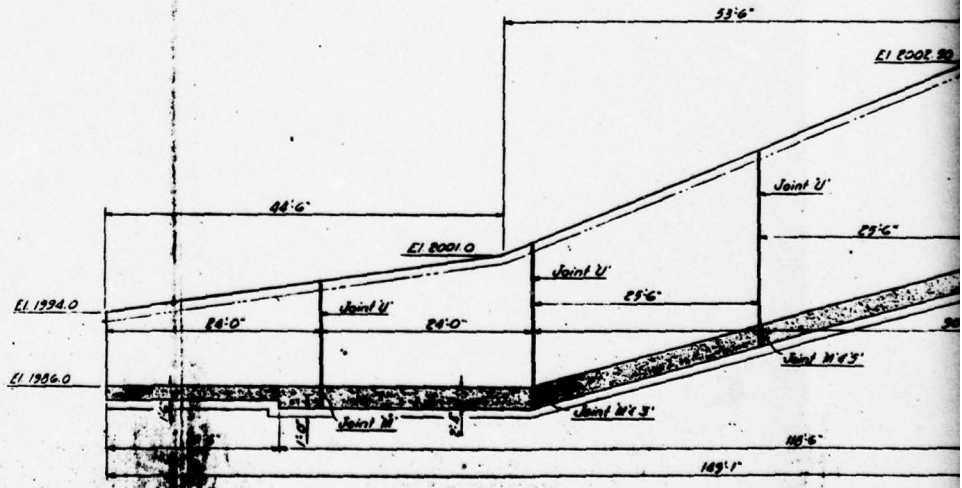
PLATE 4

D'APPOLONIA

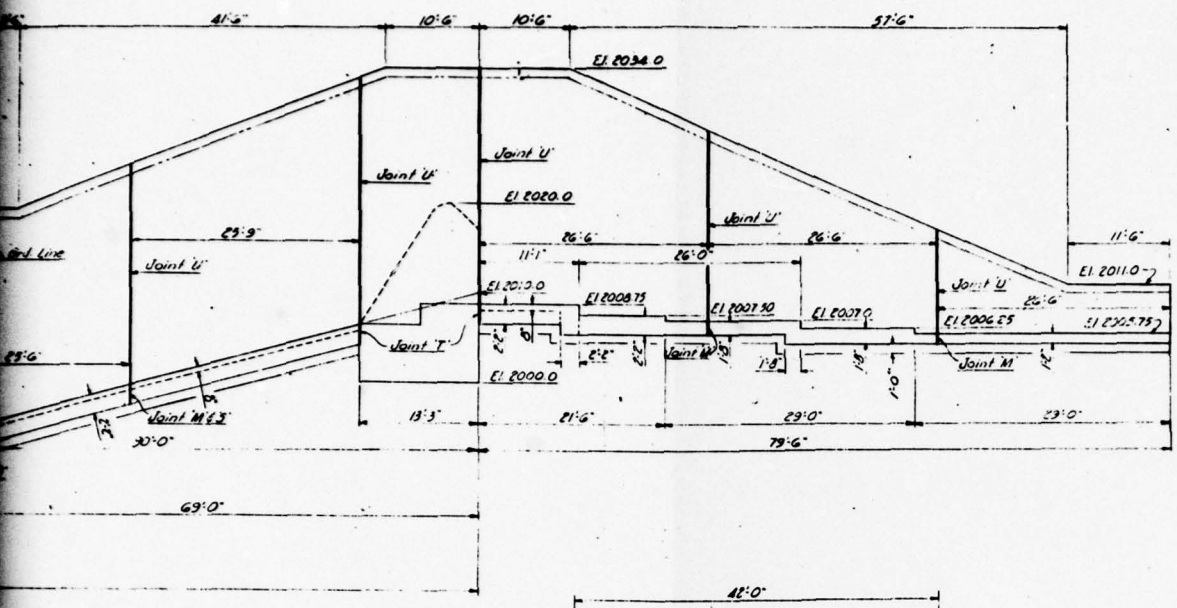
DRAWN BY		CHECKED BY		DRAWING NUMBER
	9-5-78	APPROVED BY	9-6-78	4-8177



SECTI

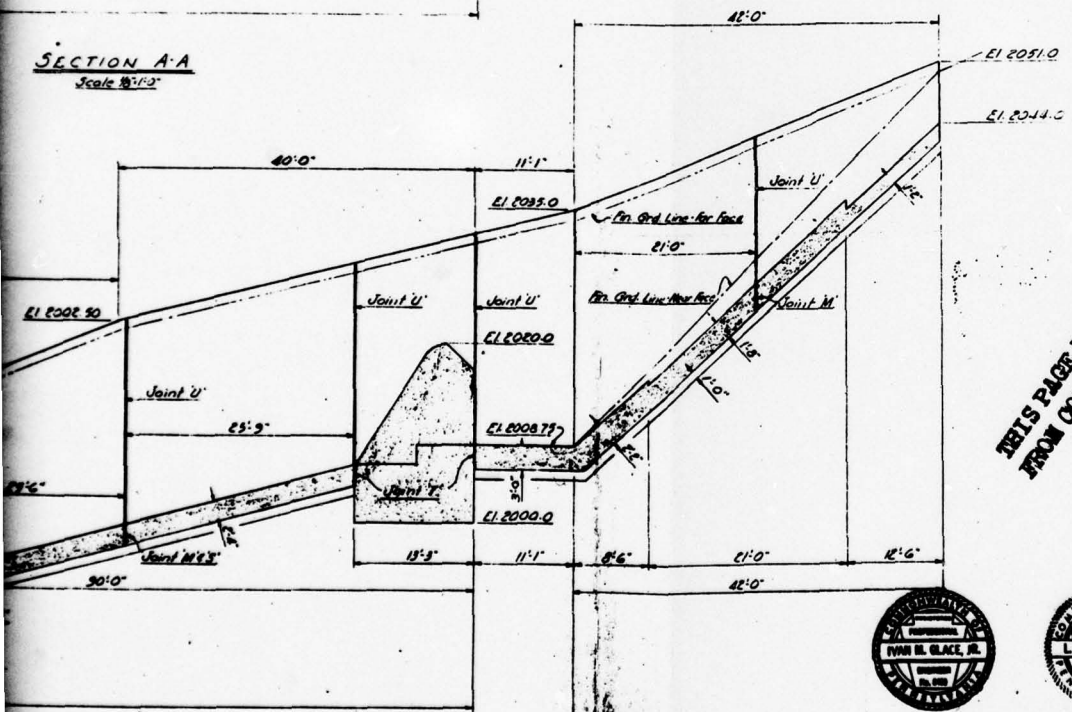


SECTION B-B



SECTION A-A

Scale 1/8"=1'-0"



NANTY GLO WATER AUTHORITY

CONTRACT 1

DETAIL OF SPILLWAY

GLACE & GLACE, L. ROBERT KIMBALL

CONSULTING ENGINEERS

9

PLATE 5

D'APPOLONIA

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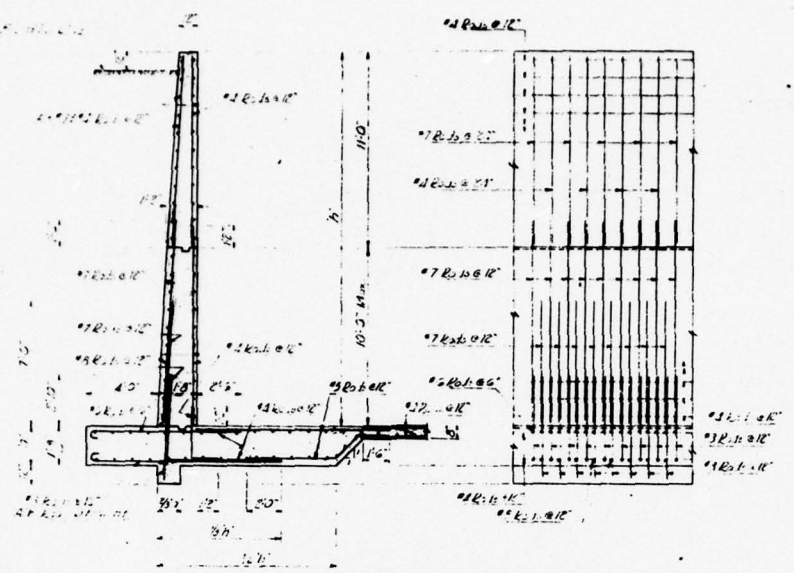
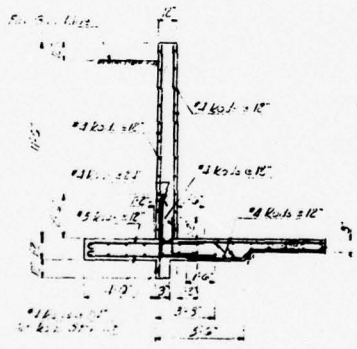
	9-5-78	APPROVED BY	JMP	9-6-78	NUMBER



SECTION E-E
Scale 1/4"=1'-0"



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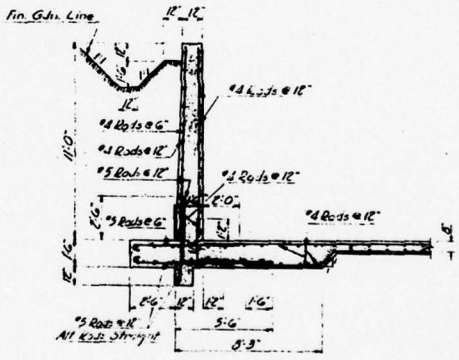
Scale 1/4"=1'-0"



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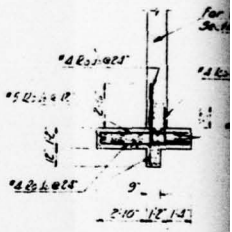

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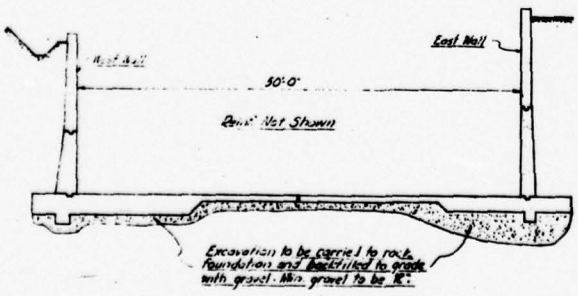

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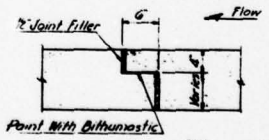

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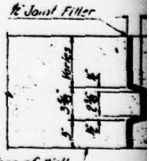

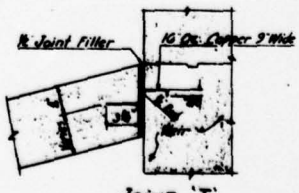

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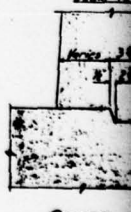
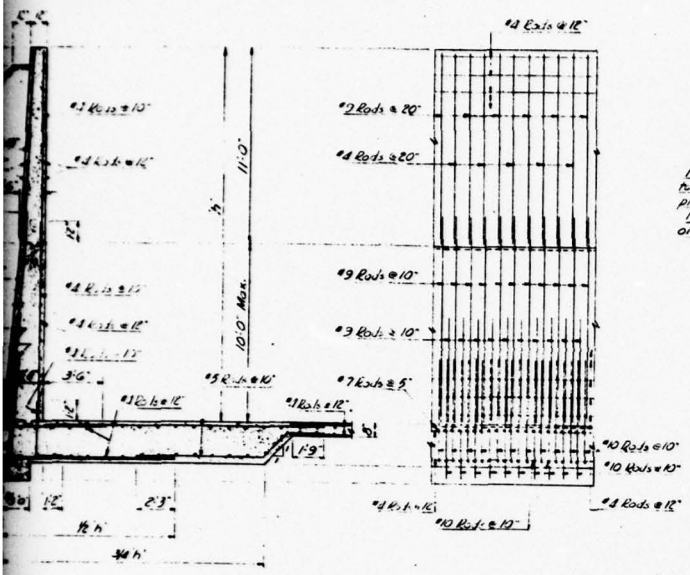


CONST.
Scale



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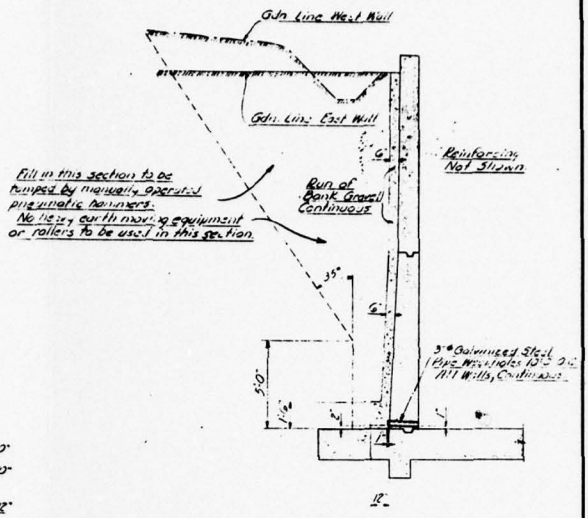

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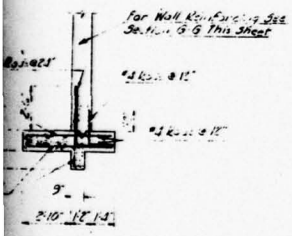

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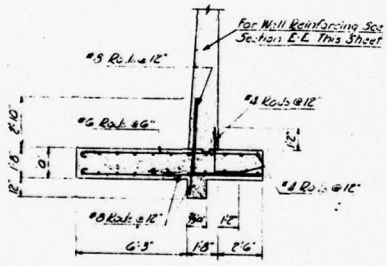

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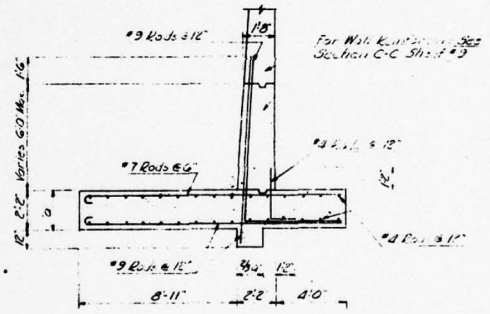

SECTION L-L
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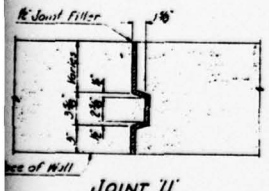

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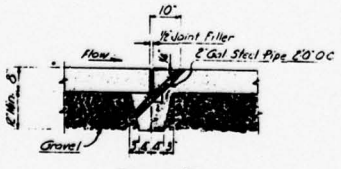
Scale 1 1/2" = 1'-0"



JOINT 'S'
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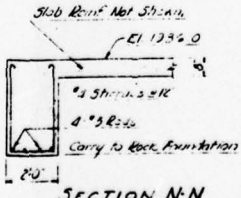
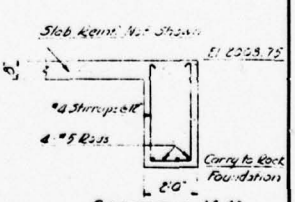
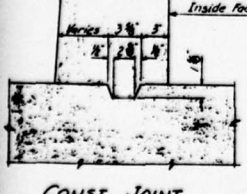


SECTION N-N
Scale 1/4" = 1'-0"



SECTION M-M
Scale 1/4" = 1'-0"



CONST. JOINT
Scale 1 1/2" = 1'-0"

MARK	REVISIONS	DATE

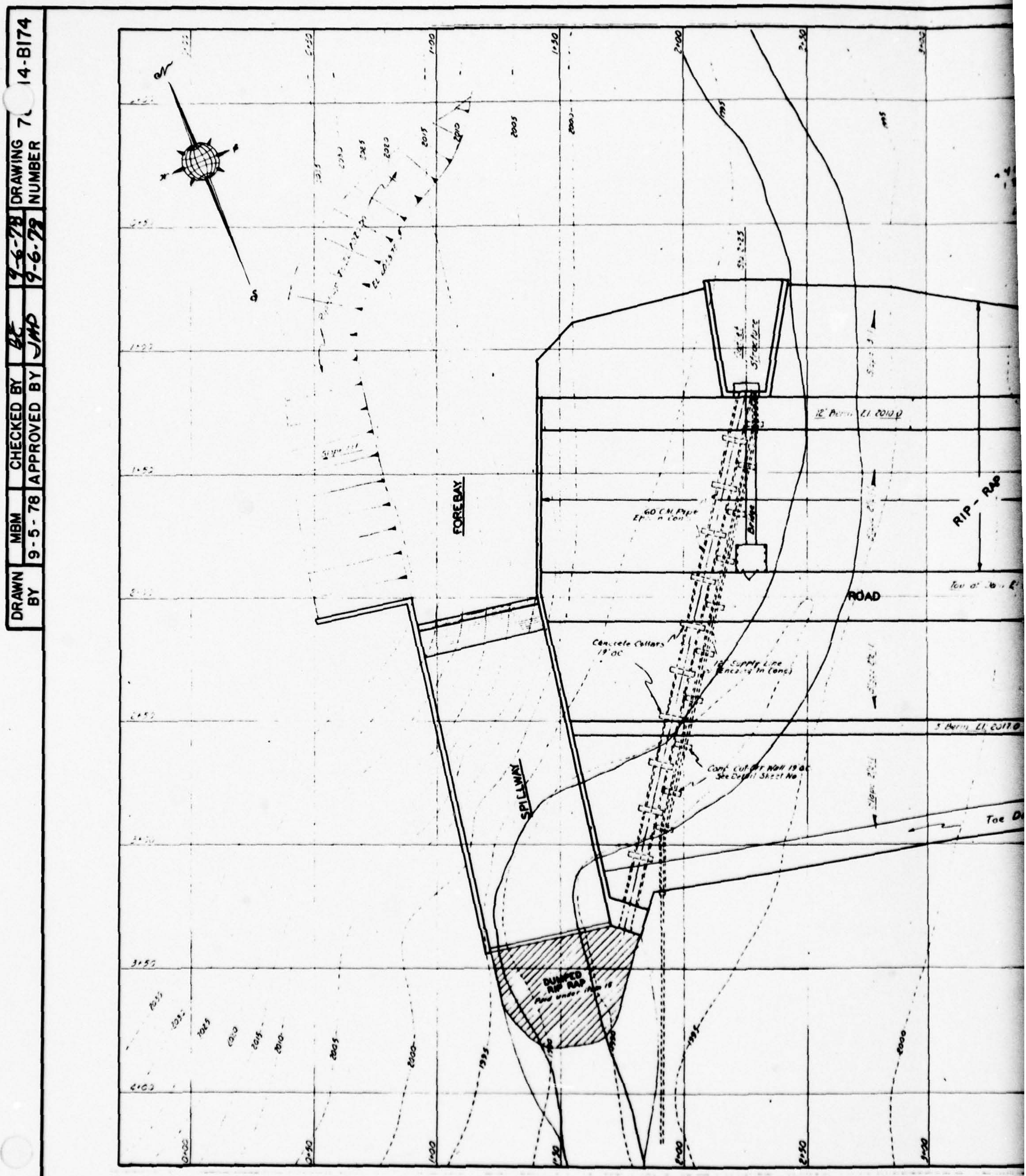
NANTY GLO WATER AUTHORITY
CONTRACT I
DETAILS OF SPILLWAY
GLACE & GLACE, L. ROBERT KIMBALL
CONSULTING ENGINEERS
HARRISBURG, PENNA. EBENSBURG, PENNA.

DRAWN BY R.E.D.	10-12-54	SCALE AS SHOWN	SHEET NO. 10
CHKD. BY		FILE CODE 5407	OF 11
APPD. BY			

PLATE 6

D'APPOLONIA

2



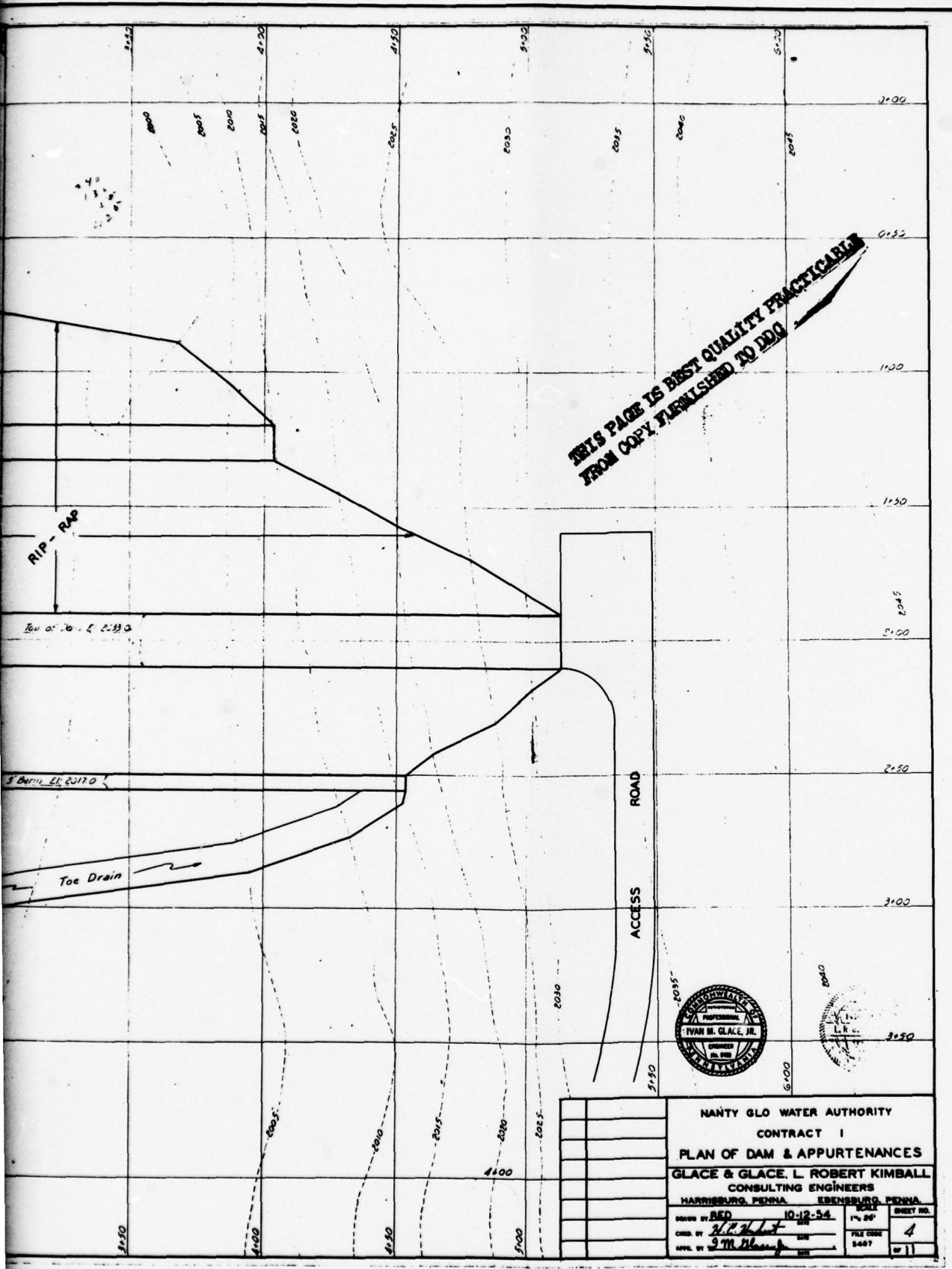
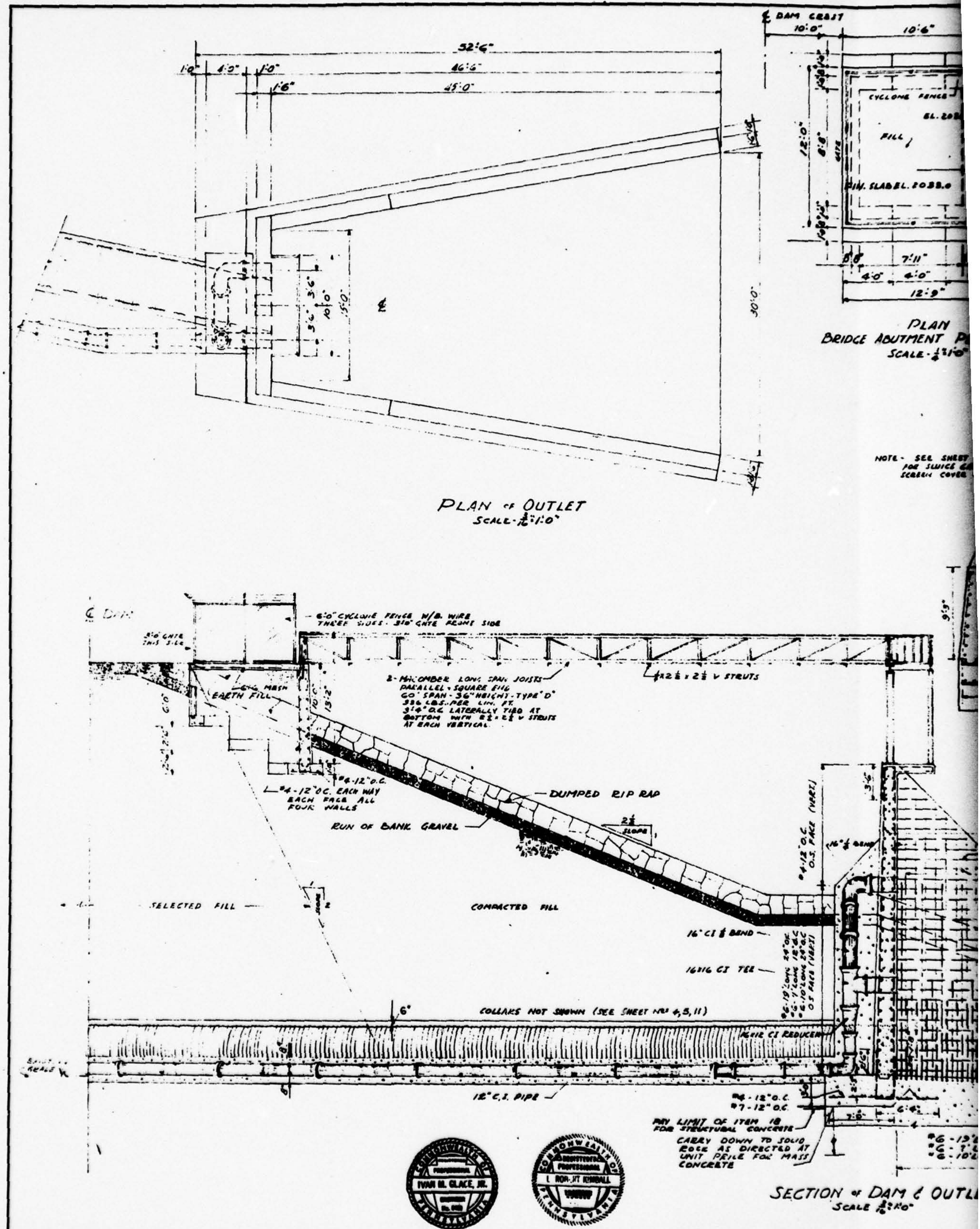


PLATE 7

D'APPOLONIA

DRAWN BY TFS 9-5-78 | CHECKED BY [initials] 9-6-78 | APPROVED BY JHP 9-6-78 | DRAWING NUMBER 7_14-B176



NANTY GLO WATER AUTHORITY

CONTRACT 1

DETAILS OF OUTLET STRUCTURE

GLACE & GLACE, L. ROBERT KIMBALL

CONSULTING ENGINEERS

HARRISBURG, PENNA. EBENSBURG, PENNA.

MARK	REVISIONS	DATE

DESIGN BY JRB 10-12-54 DATE

CHKD. BY R.C.G. DATE

APPR. BY J.M.G. DATE

SCALE AS SHOWN

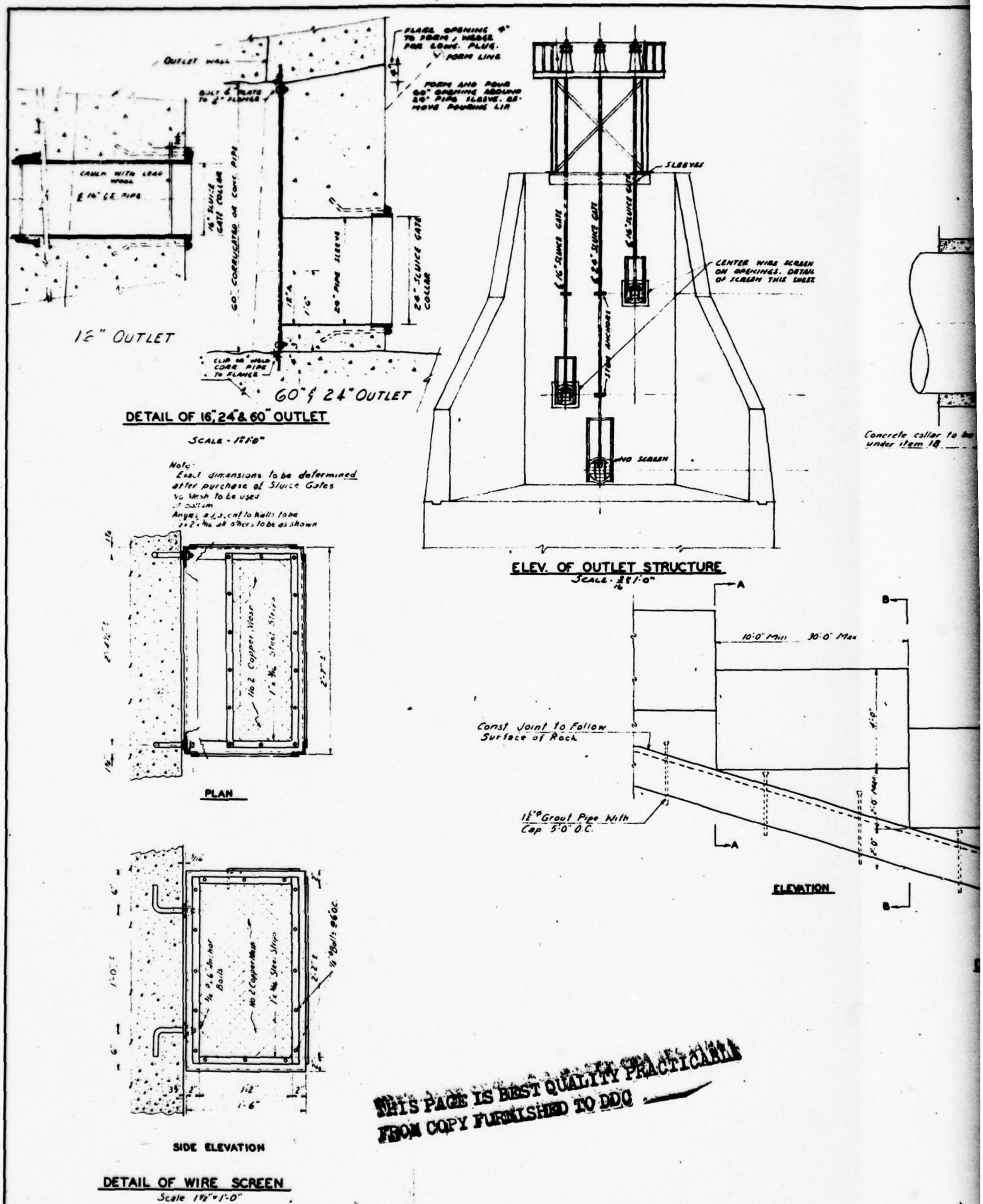
FILE CODE 5407

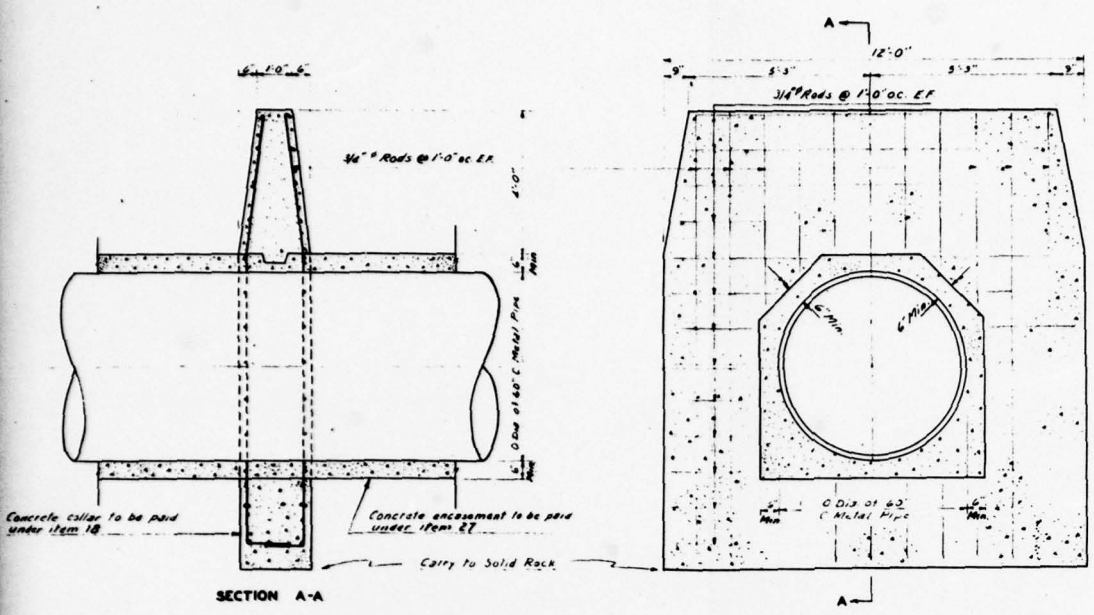
SHEET NO. 7 OF 11

PLATE 8

D'APPOLONIA

DRAWN BY	MBM	9-5-78	DRAWING NUMBER 72-14-8179
CHECKED BY		9-6-78	
APPROVED BY	JHP	9-6-78	

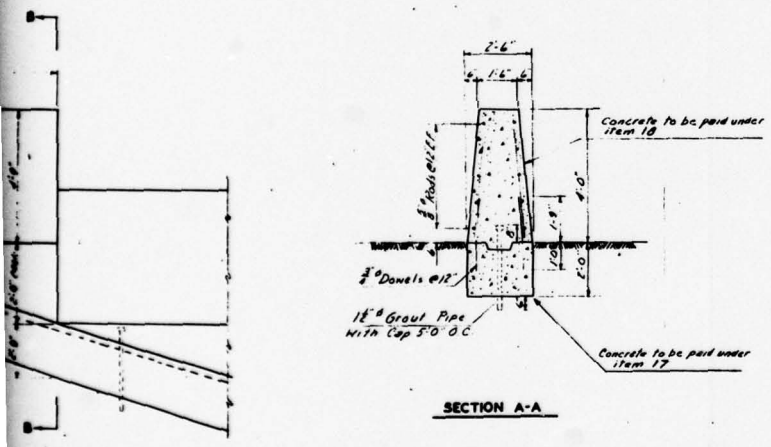




SECTION A-A

DETAIL OF CONCRETE COLLAR

Scale 1/2"=1'-0"



SECTION A-A

SECTION B-B

DETAIL OF CUT-OFF WALL

Scale 3/8"=1'-0"

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL L. ROBERT KIMBALL ENGINEER 187

COMMONWEALTH OF PENNSYLVANIA PROFESSIONAL IVAN M. GLACE, JR. ENGINEER No. 6408

MARK	REVISIONS	DATE

NANTY GLO WATER AUTHORITY
CONTRACT I
MISCELLANEOUS DETAILS

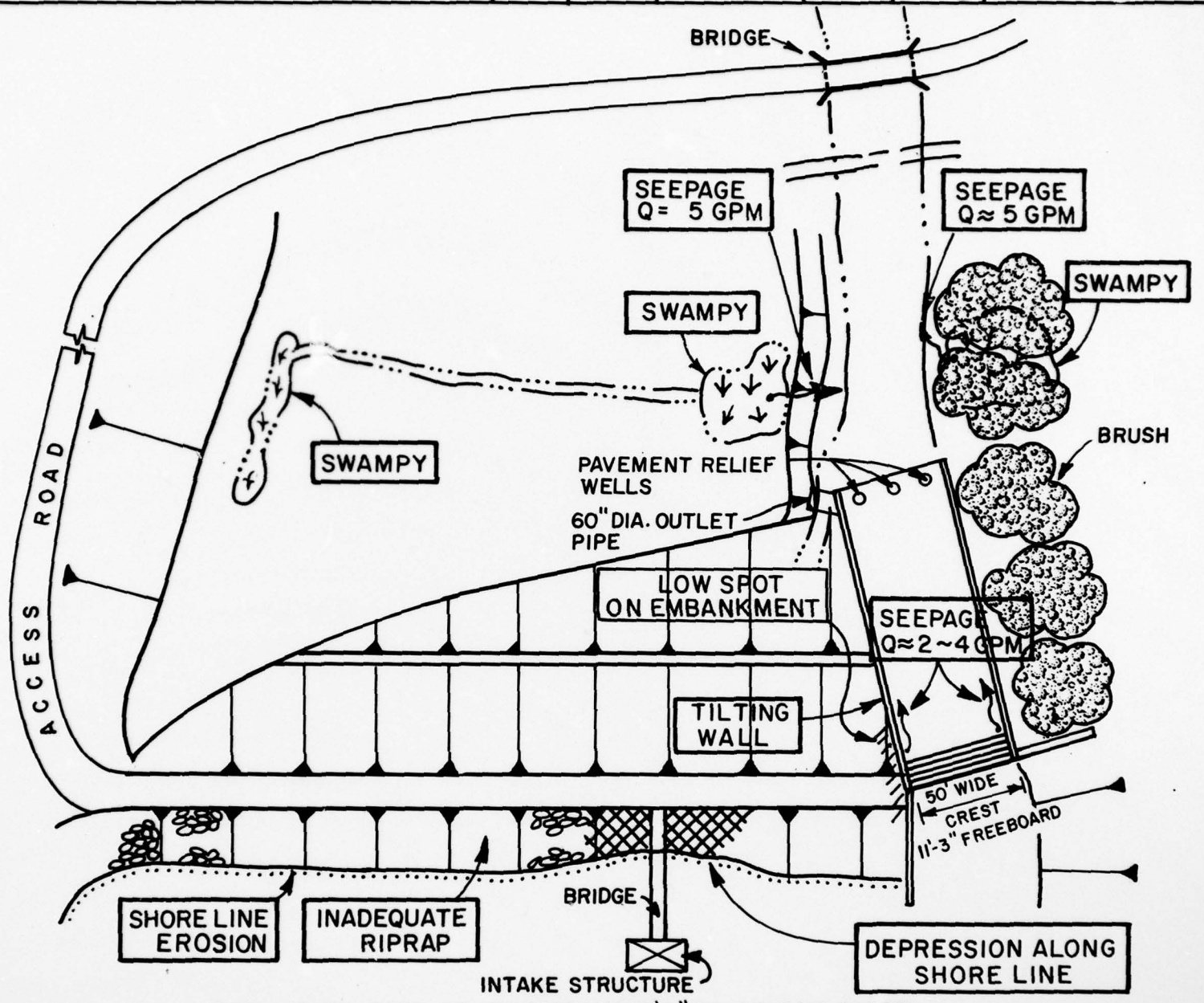
GLACE & GLACE, L. ROBERT KIMBALL
CONSULTING ENGINEERS
HARRISBURG, PENNA. EBENSBURG, PENNA.

DRAWN BY H.S.	10-12-54	SCALE AS SHOWN	SHEET NO. 11
CHKD. BY W.C. Hunkart		FILE CODE 5407	OF 11
APPD. BY L.M. Glace			

PLATE 9

D'APPOLONIA

DRAWN BY	ffw	CHECKED BY	BE	9-6-78	DRAWING NUMBER 78 1-A28
	9-8-78	APPROVED BY	JHP	7-6-78	



POOL LEVEL DATE OF INSPECTION: 11'9" BELOW DAM CREST

NOT TO SCALE

PLATE 10

WILLIAMS RUN DAM
GENERAL PLAN
FIELD INSPECTION NOTES
FIELD INSPECTION DATE: 8-31-78

D'APPOLONIA

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

CHECKLIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Williams Run COUNTY Cambria STATE Pennsylvania ID# NDI 432
DER 11-97

TYPE OF DAM Earthfill HAZARD CATEGORY Significant

DATE(S) INSPECTION August 31, 1978 WEATHER Cloudy TEMPERATURE 80's

POOL ELEVATION AT TIME OF INSPECTION 2021.3 M.S.L. TAILWATER AT TIME OF INSPECTION 1986+ M.S.L.

INSPECTION PERSONNEL:

Bilgin Erel	Review Inspection by:	Elio D'Appolonia
Wah-Tak Chan	(September 8, 1978)	L. D. Andersen
		J. H. Poellot

Bilgin Erel RECORDER

VISUAL INSPECTION
PHASE I
EMBANKMENT

NAME OF DAM Williams Run
ID# NDI 432, DER 11-97

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None found	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	A general depression was found on the upstream face below the access bridge to the intake tower. No signs of distress were observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None found	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	A low spot adjacent to the spillway wall. About 1.5 feet below mean crest elevation.	
RIPRAP FAILURES	Riprap has decomposed resulting in minor shoreline erosion.	

VISUAL INSPECTION
PHASE I
EMBANKMENT

NAME OF DAM Williams Run
ID# NDI 432, DER 11-97

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No visual signs of distress, no seepage.	
ANY NOTICEABLE SEEPAGE	Two swampy areas approximately 60 feet downstream from the toe of the dam. Flow - approximately five gallons per minute (5 gpm).	
STAFF GAGE AND RECORDER	None	
DRAINS	None	

VISUAL INSPECTION
PHASE I
CONCRETE/MASONRY DAMS

NAME OF DAM Williams Run
ID# NDI 432, DER 11-97

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	(Earth-fill dam) N/A	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	N/A	
DRAINS	N/A	
WATER PASSAGES	N/A	
FOUNDATION	N/A	

VISUAL INSPECTION
PHASE I
CONCRETE/MASONRY DAMS

NAME OF DAM Williams Run

ID# NDI 432, DER 11-97

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	(Earth-fill dam) N/A	—
STRUCTURAL CRACKING	N/A	
VERTICAL AND HORIZONTAL ALIGNMENT	N/A	
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS STAFF GAGE OF RECORDER:	N/A	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

NAME OF DAM Williams Run
ID# NDI 432, DER 11-97

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	60-inch corrugated metal pipe. Wetness at joints, no perceivable seepage.	
INTAKE STRUCTURE	Intake structure is in good condition. (The structure is accessible by pedestrian bridge.)	
OUTLET STRUCTURE	No outlet structure. The outlet pipe directly discharges into the stream.	
OUTLET CHANNEL	Natural streambed	
EMERGENCY GATE	Operated by water authority personnel and observed to be functional.	

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

NAME OF DAM Williams Run

ID# NDI 432, DER 11-97

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Ogee weir. In good condition. Minor seepage between the interface of the ogee section and the spillway walls.	
APPROACH CHANNEL	Submerged, not visible.	
DISCHARGE CHANNEL	Rectangular concrete channel. In good condition.	It is reported that in 1972 a portion of the spillway channel slab failed.
BRIDGE AND PIERS	None	

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

NAME OF DAM Williams Run

ID# NDI 432, DER 11-97

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	No gated spillway N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

NAME OF DAM Williams Run

ID# NDI 432, DER 11-97

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	

VISUAL INSPECTION
PHASE I
RESERVOIR

NAME OF DAM Williams Run

ID# NDI 432, DER 11-97

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Wooded and steep. No apparent instability.	
SEDIMENTATION	Unknown	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

NAME OF DAM Williams Run

ID# NDI 432, DER 11-97

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	No visible obstructions	
SLOPES	No apparent erosion	
APPROXIMATE NUMBER OF HOMES AND POPULATION	One home 200 feet downstream from the dam. The stream crosses Route 422 1000 feet downstream from the dam.	

APPENDIX B

CHECKLIST
ENGINEERING DATA, DESIGN,
CONSTRUCTION, OPERATION
PHASE I

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Williams Run
ID# NDI 432, DER 11-97

ITEM	REMARKS
AS-BUILT DRAWINGS	A complete set of drawings is available in state files.
REGIONAL VICINITY MAP	See Plate 1
CONSTRUCTION HISTORY	Designed by L. Robert Kimball Consulting Engineers of Ebensburg, Pennsylvania and Glace and Glace Consulting Engineers of Harrisburg, Pennsylvania in 1954. The dam was constructed by Sanctis Construction, Inc., of Pittsburgh, Pennsylvania. The dam was completed in 1956.
TYPICAL SECTIONS OF DAM	See Plate 3
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See Plates 8 and 9

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Williams Run
ID# NDI 432, DER 11-97

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	Not maintained
DESIGN REPORTS	(1) Final Report on Design of a Water Supply Project for the Nanty Glo Water Authority, by Glace and Glace and L. Robert Kimball Consulting Engineers in 1954. (2) Report on the Soils Investigation for the Nanty Glo Reservoir, by Manu-Mine Research and Development Company, September 1954.
GEOLOGY REPORTS	Included in the engineer's report.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Not available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Included in the engineer's report

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Williams Run
ID# NDI 432, DER 11-97

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	None reported
BORROW SOURCES	Indicated in the engineer's report
MONITORING SYSTEMS	None
MODIFICATIONS	None
HIGH POOL RECORDS	Not formally recorded. The dam tender reported that during Tropical Storm Agnes in 1972 the depth of water over the spillway was approximately three to four feet.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Williams Run
ID# NDI 432, DER 11-97

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None reported
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	It is reported that a portion of the spillway discharge channel slab buckled during Tropical Storm Agnes in 1972.
MAINTENANCE OPERATION RECORDS	Not available
SPILLWAY PLAN SECTIONS DETAILS	See Plate 5
OPERATING EQUIPMENT PLANS AND DETAILS	See Plate 9

NAME OF DAM Williams Run

ID# NDI 432, DER 11-97

CHECKLIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Wooded, 4.8 square miles

ELEVATION; TOP NORMAL POOL AND STORAGE CAPACITY: 480 acre-feet at El. 2120

ELEVATION; TOP FLOOD CONTROL POOL AND STORAGE CAPACITY: Same as above

ELEVATION; MAXIMUM DESIGN POOL: El. 2033 (top of dam)

ELEVATION; TOP DAM: El. 2033 (low spot El. 10313±)

CREST: (Spillway)

a. Elevation 2020

b. Type Ogee weir

c. Width 50 feet

d. Length N/A

e. Location Spillover Adjacent to spillway discharge channel

f. Number and Type of Gates None

OUTLET WORKS:

a. Type 60-inch corrugated metal pipe

b. Location Left of spillway channel

c. Entrance Inverts El. 1992

d. Exit Inverts El. 1986±

e. Emergency Draindown Facilities 60-inch corrugated metal pipe

HYDROMETEOROLOGICAL GAGES:

a. Type None

b. Location None

c. Records None

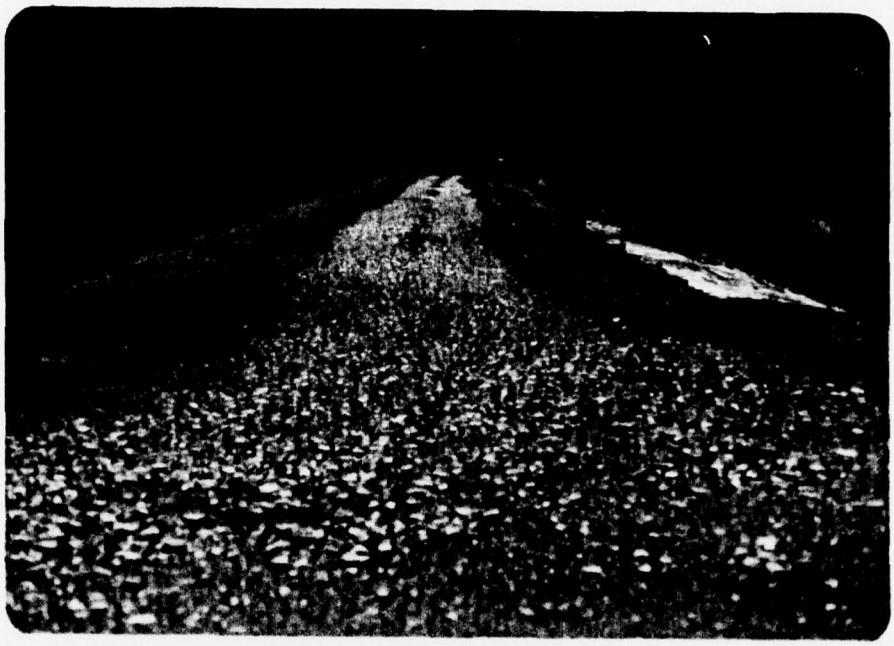
MAXIMUM NONDAMAGING DISCHARGE: Spillway capacity (7200 cfs)

APPENDIX C

PHOTOGRAPHS

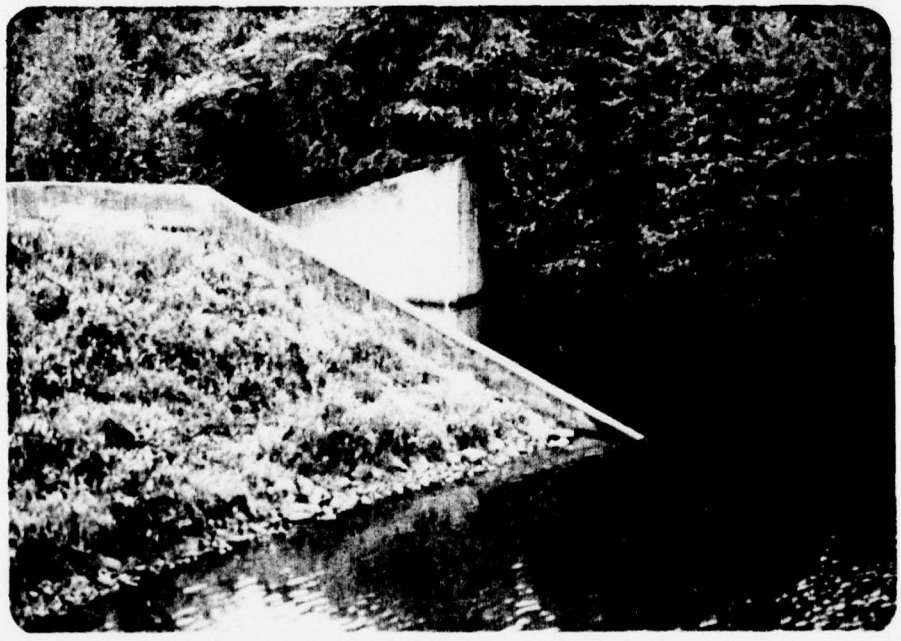
LIST OF PHOTOGRAPHS
WILLIAMS RUN DAM
NDI I.D. NO. 432
AUGUST 31, 1978

PHOTOGRAPH NO.	DESCRIPTION
1	Crest (looking east).
2	Spillway approach channel.
3	Spillway crest.
4	Spillway chute (note drainpipe outlet on righthand side).
5	Upstream valve controls.
6	Right spillway wall (looking downstream) five inches out of plumb.
7	Culvert under Route 422 (looking downstream).
8	South Branch of Black Lick Creek at Nanty Glo (six miles downstream).



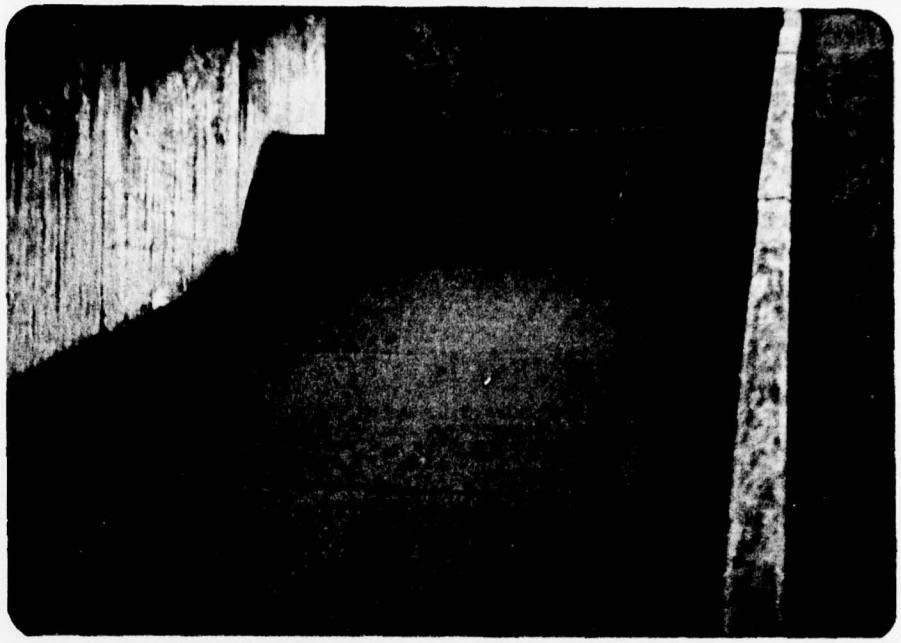
Photograph No. 1

Crest (looking east).



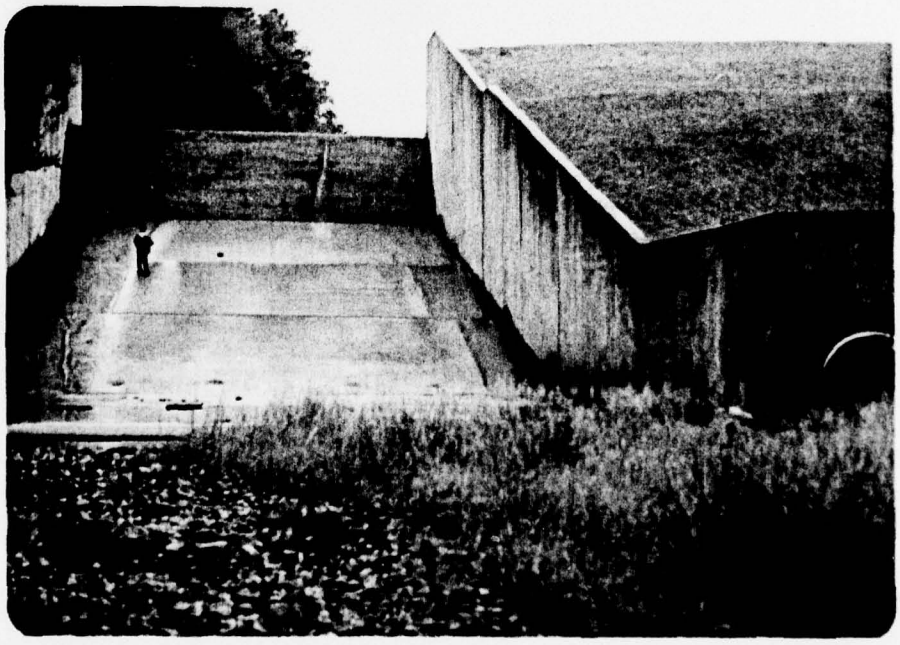
Photograph No. 2

Spillway approach channel.



Photograph No. 3

Spillway crest.

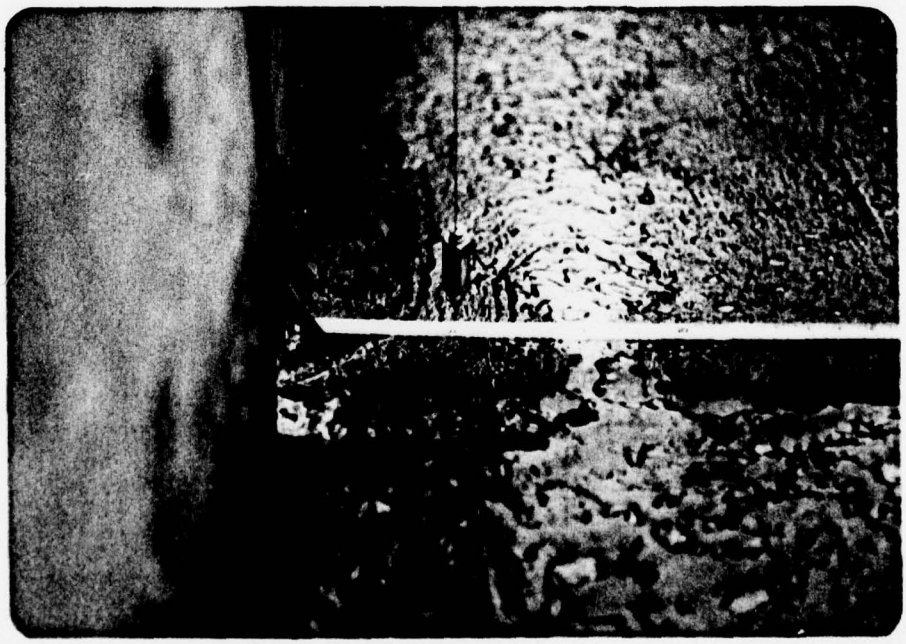


Photograph No. 4

Spillway chute (note drainpipe outlet on righthand side).

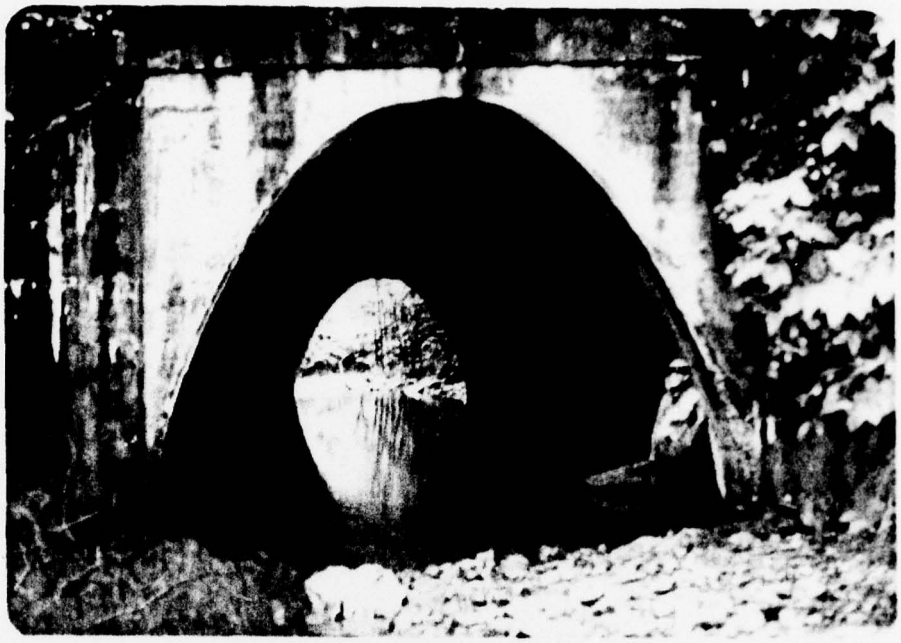
Photograph No. 5

Upstream valve controls.



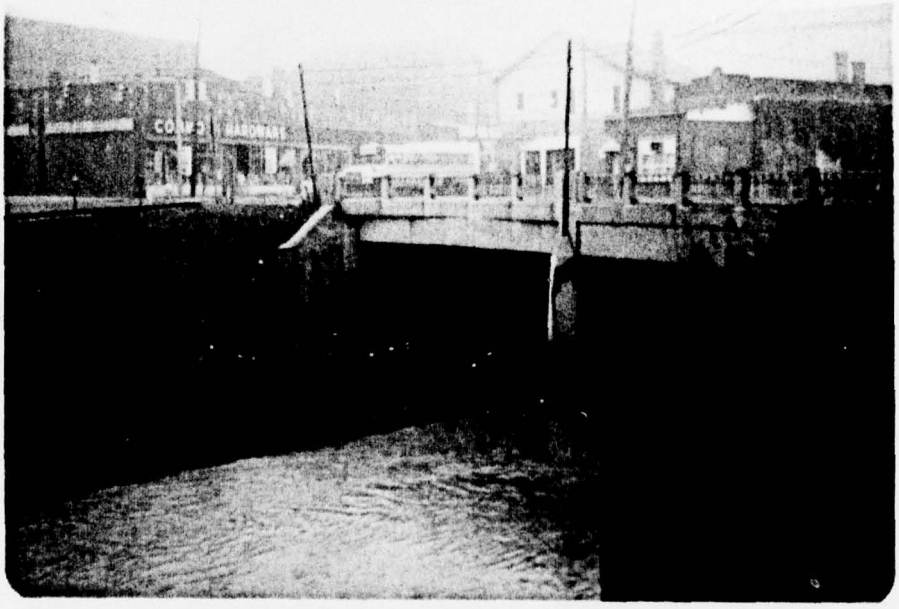
Photograph No. 6

Right spillway wall (looking downstream) five inches out of plumb.



Photograph No. 7

Culvert under Route 422 (looking downstream).



Photograph No. 8

South Branch of Black Lick Creek at
Nanty Glo (six miles downstream).

APPENDIX D

CALCULATIONS

DAMPODLONIA
CONSULTING ENGINEERS, INC

By MB Date 9/25/78 Subject WILLIAMS RUN DAM Sheet No. 1 of 1
Chkd. By WTC Date 9/25/78 WATERSHED & LAKE AREA Proj. No. 78-114-27
0.5cm. X 0.5cm.

WATERSHED AREA

REF. U.S.G.S. COLVER & CARROLLTOWN, PA. QUADRANGLE

A) WATERSHED AREA:

1) COLVER — 26.65
2) CARROLLTOWN — 3.90

AREA = 30.55 IN^2

$= 30.55 \times \left(\frac{2000}{5280}\right)^2$

= 4.4 SQ MILES

WATERSHED FROM STATE FILE = 4.8 SQ MILES

SAY 4.8 SQ MILES

B) LAKE AREA (EL 2019)

A_L = 0.76 IN^2

$= .76 \times \left(\frac{2000}{5280}\right)^2 \times 640$

A_L = 69 ACRES

SAY 70 ACRES

C) TOP OF DAM - EL. 2040

A_{EL2040} = 1.81 IN^2

$= (1.81)\left(\frac{2000}{5280}\right)^2 (640) = 166.2$ ACRES @ EL. 2040

TOP OF DAM $A_D \approx \left(\frac{166.2-69.8}{2040-2019}\right)(11.25^*) + 69.8$

A_D = 121.4

SAY 120 ACRES

D) SURCHARGE VOLUME:

$VOL = \frac{11.25}{3}\left(70 + 120 + \sqrt{70 \times 120}\right)$

VOL = 1056 ACRE-FT

SAY 1050 AC-FT

* FIELD MEASUREMENT

IDAPPOLONIA
CONSULTING ENGINEERS, INC

By WTC Date 9-20-78 Subject WILLIAMS RUN DAM Sheet No. 1 of 2
Chkd. By CMB Date 9/25/78 HYDROLOGY & HYDRAULIC Proj. No. 78-114-28

DAM WILLIAMS RUN DAM

BASIN : SUSQUEHANNA RIVER BASIN REGION #1, WILLIAMS RUN OF BLACK LICK CREEK NEAR NANTY-GLO, PA

WATERSHED AREA, A = 4.8 SQ. MILES

ACCORDING TO THE HYDROLOGICAL CHARTS PROVIDED BY COE BALTIMORE DIST.

PMF PEAK INFLOW RATE $q = 2900$ cfs/SQ MILE

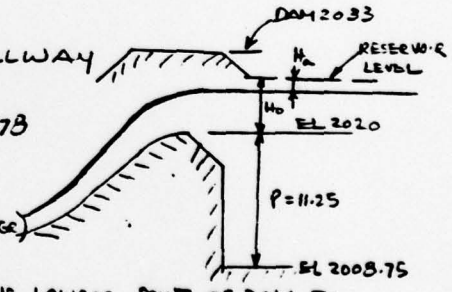
$= 13920$ cfs

say 14000 cfs

26" RUNOFF $V_1 = \frac{26}{12} \times 4.8 \times 640 = 6656$ ac-ft

say 6700 ac ft

SPILLWAY
50' CONCRETE OGEE LIKE SPILLWAY



REF: DESIGN OF SMALL DAM 2nd ED P 378

P = 11.25
H_o = 2033 - 2020 (Reported by owner)
= 13 FT
Field measurements INDICATE THE LOWEST POINT OF DAM TO CREST OF spillway = 11'-3"
Use H_o = 11.25'

$\frac{P}{H_o} = \frac{11.25}{11.25} = 1.0$

$C_o = 3.89$ from Fig 249

$\frac{C_{inclined}}{C_{vertical}} = 0.98$ (assuming a 1:1 u/s slope)

$C_o' = 0.98 \times 3.89 = 3.81$

$Q = C_o' L H_o^{3/2}$

$= (3.81)(50)(11.25)^{1.5}$

$= 7192$ cfs

Say 7200 cfs

SURCHARGE STORAGE

LAKE AREA ≈ = 70 ± ACRES (EL 2019)
TOP OF DAM ≈ 120 ACRES (EL 2033) } See P 1 of 1
VOL = 1050 acre-ft (BETWEEN EL 2019 & LOWEST POINT of DAM 2030.5)

Say 1050 ac ft

PERCENT OF PMF

$= \left(\frac{7200}{14000} + \frac{1050}{6700}\right) 100\%$

$= (0.51 + 0.16) 100\%$

$= 67.1\%$

Say 67% PMF

APPENDIX E

REGIONAL GEOLOGY

APPENDIX E
REGIONAL GEOLOGY

The Williams Run Dam is situated on rock strata of the Middle to Lower Conemaugh Group. The dam is just west of the Johnstown-Bradley Syncline and east of the Laurel Ridge Anticline. The strata that crop in the vicinity of the dam consist of black to dark gray shale. In general, strata of the Conemaugh Group consist of interbedded shale, claystone, sandstone, and several thin coal seams. The Lower Kittanning coal seam has been mined[1] beneath the site in Bethlehem Mines Nos. 32 and 33, and the Upper Freeport coal seam may have been mined approximately 235 feet below the ground surface. There have been few reports of surface subsidence caused by mining in this region. Based on the amount of rock cover over the mines and the possible existence of massive sandstone layers, there does not appear to be an immediate danger of surface subsidence. However, there is a strong possibility of surface subsidence at some time in the future, depending on the type of mining and local geology. An air shaft for a mine is located just west of the reservoir. In addition to the Upper Freeport and Lower Kittanning coal seams, the Lower Freeport and Upper Kittanning coal seams are probably minable in the vicinity.

The slopes in the vicinity of the reservoir are relatively gentle, reflecting the ease of weathering of the fine-grained Conemaugh rock strata. No large slides should occur, although minor creep may be expected.

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(1) Commonwealth of Pennsylvania, Department of Environmental Resources, Bureau of Land Protection, Division of Mine Subsidence Regulation, Mine Map of Cambria County, January 1975.